

Sleep Quality and Associated Factors in Elderly Patients with Type-2 Diabetes Mellitus

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ABSTRACT

Objective: The prevalence of poor sleep quality has been greatly escalating over the past years, along with the surging of type 2 Diabetes Mellitus (DM). The aging population is most concerned as sleep quality is notably impaired and influences the diabetic condition. This study aimed to observe the sleep quality and factors related to poor sleep quality in elderly patients with type-2 DM.

Materials and Methods: A cross-sectional study of patients with type 2 DM, aged 60 years and above was conducted. The questionnaires included demographic data, the Thai version of the Pittsburgh Sleep Quality Index (T-PSQI), the Thai version of the Diabetic-39, and the Thai Geriatric Depression Scale-15. Factors associated with sleep quality were analyzed using the logistic regression model.

Results: Among 385 participants with a mean age of 67 years old was 63.90% female. The prevalence of poor sleep quality was 9.88%. No association was found between sleep quality and glycemic levels. The related factors for poor sleep quality were sex (aOR = 2.57, $p = 0.035$, 95%CI = 1.06-5.93), body mass index (aOR = 1.09, $p = 0.028$, 95% CI = 1.00-1.20), and diabetic complications. Diabetic retinopathy showed highest odd ratio (aOR = 6.28, $p = 0.021$, 95% CI = 1.32-29.94).

Conclusion: The prevalence of poor sleep quality was low in the current study. We found a strong association between diabetic complications and poor sleep quality. Evaluation of sleep quality may help to enhance overall health and care for diabetic geriatric patients.

Keywords: Sleep quality; poor sleep quality; diabetes mellitus type 2; elderly, geriatric (Siriraj Med J 2023; 75: 392-398)

INTRODUCTION

Sleep problem is a common public health concern around the world.^{1,2} Sleep problem affects overall health, leads to lethargy, lack of enthusiasm, decreased immunity, increased stress, and reduced quality of life.² Sleep problem was classified into different groups by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria, and the core features of each group encompass sleep quality. Sleep quality relates to timing, amount of sleep, daytime distress, and self-reported satisfaction regarding the quality of sleep which has

been divided into seven dimensions in consonance with The Pittsburgh Sleep Quality Index (PSQI).³ These include subjective sleep quality, sleep latency (how long it takes the person to fall asleep), sleep duration (hours of actual sleep), habitual sleep efficiency (the percentage of time in bed that the person is asleep), sleep disturbance (any issues, feelings, and symptoms that disturb sleep), use of sleep medications, and daytime consequences (concentration, daily performance).⁴ Poor sleep quality is one of the major psychosocial issues that impact all aspects of health and quality of life.⁵

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Received 10 January 2023 Revised 1 April 2023 Accepted 3 April 2023

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<https://doi.org/10.33192/smj.v75i5.260818>



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The prevalence of poor sleep quality is considerably high in elderly patients⁶, especially elder with chronic illnesses, such as hypertension, heart disease, and diabetes.^{7,8} Diabetes is one of the major chronic conditions which has high morbidity and mortality in the elderly and all ages.^{1,9} reveal that poor sleep quality increases insulin resistance, reduces the acute insulin response to glucose and is associated with glucose intolerance^{10,11} results in higher blood sugar levels and increases diabetes complications.¹¹ Other explanations for poor sleep quality sequences establishing endothelial dysfunction, aggravating inflammatory markers, and activating of systemic inflammation.¹² It has been reported that more than half of patients with diabetes mellitus have poor sleep quality with the prevalence of poor sleep quality is greater in type 2 diabetes patients than in the general population.¹³ Many elderly patients with type-2 diabetes confront challenges to their sleep, still, they do not bring sleep issues when they come to a health institution for a follow-up. Consequently, poor sleep quality is usually unrecognized in elderly with diabetes, also, studies on this issue are scarce. This study aimed to examine the sleep quality and factors related to poor sleep quality in elderly diagnosed with type-2 diabetes.

MATERIALS AND METHODS

Consent and Ethical Approval

The study was approved by the Human Research Ethics Committee of the Phrae Hospital (No: 21/2019). Informed consent was obtained from all participants.

Participants

This cross-sectional study recruited elderly patients who received outpatient clinic follow-up at the outpatient clinic of Phrae Tertiary care Hospital. Inclusion criteria included age of 60 years and older who were diagnosed with type 2 diabetes based on ADA criteria and Thai diabetes guidelines 2018. The exclusion criteria were unwillingness to enroll, severe hearing or vision impairment, dementia, or any other conditions affecting the ability to understand and complete the questionnaire regardless of assistance from the clinic nurse.

Sample Size Determination

The sample was calculated using the Thorndike formular (Thorndike, 1978), $N \geq 10K + 50$, where N is the sample size, and K is the total studied variables. Study variables were reviewed and finalized to 30 variables.^{7,11,14,15} Also for 10% of the non-response rate of 350, the total sample size was 385. Purposeful sampling from outpatient clinic by nurse, 9-12.00 am during clinic operating time.

400 meet criteria exclude 15 due to missing data. Final sample was 385.

Data collection and questionnaires

Data were collected between November 2019 and April 2020. The questionnaire consisted of basic information, the Thai version of the Pittsburgh Sleep Quality Index (T-PSQI) (16), and the disturbing factors of the sleep questionnaire.^{7,11,14,15} The Thai version of the Diabetic-39 (D-39) was used to collect quality of life in diabetes patients (a reliability of 0.85).¹⁷ D-39 composed of 6 dimensions: diabetes control, energy and mobility, anxiety and worry, social burden, sexual functioning and overall quality of life, higher number rated in each dimensions indicated larger effect from the disease to quality of life. And the Thai Geriatric Depression Scale-15 (TGDS-15, a sensitivity of 0.92 and a specificity of 0.87) was used to determine depression.¹⁸

Data analysis

Statistical data were analyzed using STATA for Windows version 15. The prevalence of poor sleep quality was analyzed as frequency and percentage. The disturbing factors of sleep were analyzed using the Chi-square test and factors associated with poor sleep quality were analyzed by Logistic regression. A *P* value of < 0.05 was considered statistically significant.

Operation Definition

1. The elderly was defined as people age 60 years and older. (WHO Criteria for Asian)
2. Good sleep quality was defined as T-PSQI scores 5 or less than 5.
3. Major depression suspected was defined as the TGDS-15 scores more than 4.
4. Diabetic complications were defined as follows:
 - Diabetic neuropathy included having symptom of paresthesia, numbness, restless leg syndrome caused by diabetes and diagnosed by physicians.
 - Diabetic retinopathy diagnosed by ophthalmologists via full ophthalmic examination.
 - Diabetic nephropathy with impairment in creatinine clearance of eGFR less than 80.
 - Chronic wound was described as a wound that fails to proceed through the normal phases of wound healing and with proper treatment over one month.¹⁹

RESULTS

Patient characteristics

Of the total 385 diabetic patients, 63.90 percent were female, and the mean age was 67.31 ± 5.76 years old. The

mean global score of T-PSQI were 2.8 in average, and 2.3 in the good sleep quality group versus 7.5 in the poor sleep quality group ($p < 0.001$). Marital, income, exercise, alcohol drinking and smoking status were similar in both groups. Body mass index (BMI) between the good and poor sleep quality groups were statistically significant differences (mean 23.68 ± 3.35 in good sleep vs 25.69 ± 4.88 in poor sleep group, $p = 0.004$).

Disease factors and quality of life in diabetic patients

The poor sleep quality group had 2.6 times higher for diabetic complications than the good sleep quality group, 36.84% vs 14.12%, $p = 0.001$. Two types of diabetic complications that yielded a significant difference between the two groups were diabetic neuropathy and retinopathy ($p < 0.001$). No difference was shown in the type of pharmacological treatment and the laboratory results. The energy mobility dimension in the quality of life for diabetic patients showed a significant difference ($p = 0.007$).

Environmental factors

All the environmental factors including noise, light, roommate, and animals or insects provided statistically significant differences between groups ($p = 0.012, 0.006, 0.027$, and 0.046 , respectively).

Prevalence of poor sleep quality among elderly with diabetes was 9.88%. More than 70% had very good subjective sleep quality and sleep efficiency (self-rated sleep efficacy for more than 85%). Half of the patients had sleep latency between 16-30 minutes. Eighty-six percent had a sleep duration of more than 7 hours per night. The sleep disturbance score was in the low range (0-1). Sleep disturbances from question lists; have to get up to use the bathroom, cannot breathe comfortably, and having pain at nighttime, were mainly reported less than once a week. Most of the participants did not use sleep medicine. Daytime dysfunction score was calculated, this component was scored low (score = 0) in 77% of the participants. There were statistically differences of all components in PSQI between good and poor sleep quality groups ($p = 0.001$). PSQI score could also indicate sleep hygiene which lower score imply to less sleep difficulty. In our study, higher PQSI (marked sleep difficulty) were consistence with poor sleep quality. These results were demonstrated in Table 2.

On logistic regression (Table 3), we selected variables with p -value < 0.05 and two universal variables (sex, age) from table 1 to analyze. The significant associated factors of poor sleep quality were sex (female) (AOR 2.57, 95% CI 1.06 - 5.93), body mass index (AOR 1.09,

95% CI 1.1-6.2), diabetic neuropathy (AOR 4.12, 95% CI 1.70 - 9.99), and diabetic retinopathy (AOR 6.28, 95% CI 1.32 - 29.94).

DISCUSSION

The current study focused on sleep quality in the context of elderly patients with diabetes by examining PSQI and factors related to poor sleep quality. The prevalence of poor sleep quality in this study was approximately 10% which is very low compared to other studies in the different races and topography that varied from 36.5% to 73.2%.^{1,15,20} The rural residence was positively associated with good sleep quality.²¹ The quality of sleep results from T-PSQI: overall sleep quality was very good. And thoroughly subcomponents of T-PSQI showed good sleep efficacy, short sleep latency, suitable sleep duration, and low sleep disturbances, which explained the good level of baseline sleep status in our population.

When comparing between the good and poor sleep quality groups, significant differences in mean BMI, diabetic complications, energy mobility dimension of quality of life, and environmental factors was noted. These factors received further logistic regression analysis.

Analyzing factors associated with poor sleep quality using the logistic regression adjusted by sex, body mass index, diabetic complications, noise, light, roommate, animal or insects, and energy mobility (dimension of quality of life) showed four factors associated with poor sleep quality. 1) Females are more likely than males to report poor sleep, inconsonant with previous studies which identified between 50-70% of insomnia prevalence which possibly an effect from hormonal change after postmenopause.^{5,22} 2) Higher BMI was associated with poor sleep quality. This finding rationalized that increasing BMI magnified the likelihood of obstructive sleep apnea syndrome (OSAS),²³ which causes intermittent sleep apnea and periodic wakefulness (poor sleep quality and efficacy). However, there was also bidirectional effects, short sleep duration and sleep fragmentation could result in low leptin, high appetite, and decrease in energy expenditure, caused weight gain, obesity and precipitated OSAS. Therefore, monitoring BMI and overweight status may help physicians for early detection or preventing development of OSAS which affect sleep quality. And also, encouraging healthy sleep hygiene may help reducing body weight and insulin resistance in elderly patients with diabetes. 3) The odds of having poor sleep quality are increased when presented with diabetic neuropathy. Common manifestation of diabetic neuropathy liked paresthesia, restless leg syndrome which were usually worsen during nighttime could

TABLE 1. Patient characteristics and associated factors in good and poor sleep quality groups.

Patient characteristics	Total N (%) (N=385)	Good quality N (%) (N=347)	Poor quality N (%) (N=38)	P-value
Sex - Female	246 (63.90)	217 (62.54)	29 (76.32)	0.093
Age (years) (Mean \pm SD)	67.31 \pm 5.76	67.48 \pm 5.80	65.71 \pm 5.17	0.071
T-PSQI score (Mean \pm SD)	2.79 \pm 2.10	2.28 \pm 1.36	7.50 \pm 1.84	<0.001
Marital status - Married	312 (81.04)	285 (82.13)	27 (71.05)	0.098
Income per month				
< 10,000 baht	309 (80.26)	276 (79.54)	33 (86.84)	0.283
\geq 10,000 baht	76 (19.74)	71 (20.46)	5 (13.16)	
Exercise frequency				
1-5 times a week	229 (59.48)	203 (58.50)	26 (68.42)	0.497
Everyday	143 (37.14)	132 (38.04)	11 (28.95)	
Alcohol drinking	55 (14.28)	51 (14.70)	4 (10.53)	0.485
Smoking	6 (1.56)	5 (1.44)	1 (2.63)	0.574
Body mass index (kg/m ²)				0.010
< 18.5	11 (2.86)	9 (2.59)	2 (5.26)	
18.5 – 22.9	171 (44.42)	162 (46.69)	9 (23.68)	
23.0 – 24.9	91 (23.64)	83 (23.92)	8 (21.05)	
\geq 25.0	112 (29.09)	93 (26.80)	19 (50.00)	
Mean BMI \pm SD	23.88 \pm 3.57	23.68 \pm 3.35	25.69 \pm 4.88	0.004
Disease factors				
Years since diabetes diagnosis mean \pm SD	7.76 \pm 4.37	7.67 \pm 4.22	8.57 \pm 5.58	0.227
Comorbidities - yes	326 (84.67)	292 (84.15)	34 (89.47)	0.387
Major depression	137 (35.58)	121 (34.87)	16 (42.11)	0.376
Any diabetic complications	63 (16.36)	49 (14.12)	14 (36.84)	0.001
Type of diabetic complications				
Diabetic neuropathy	54 (14.03)	40 (11.53)	14 (36.84)	<0.001
Diabetic retinopathy	9 (2.34)	5 (1.44)	4 (10.53)	<0.001
Diabetic nephropathy	6 (1.56)	5 (1.44)	1 (2.63)	0.57
Chronic wound	6 (1.56)	5 (1.44)	1 (2.63)	0.57
DM Treatment				
Oral medications only	385 (98.96)	343 (98.85)	38 (100)	0.506*
Oral medications and insulin	4 (1.04)	4 (1.15)	0 (0)	
HbA1c (Mean \pm SD)	7.25 \pm 1.49	7.22 \pm 1.50	7.49 \pm 1.40	0.305
FBS (Mean \pm SD)	135.93 \pm 34.95	136.38 \pm 35.83	131.78 \pm 25.57	0.442
LDL (Mean \pm SD)	97.57 \pm 29.76	96.87 \pm 29.88	103.92 \pm 28.29	0.166
TG (Mean \pm SD)	136.00 \pm 82.58	136.54 \pm 85.73	131.05 \pm 44.96	0.697
Quality of life for diabetic patients				
Diabetes Control	16.41 \pm 8.65	16.49 \pm 8.63	15.69 \pm 8.91	0.589
Anxiety and worry	15.85 \pm 9.55	15.72 \pm 9.29	17.01 \pm 11.72	0.432
Social Burden	14.68 \pm 7.98	14.78 \pm 8.03	13.75 \pm 7.57	0.453
Sexual Function	14.10 \pm 8.66	14.21 \pm 8.65	13.15 \pm 8.83	0.478
Energy Mobility	16.60 \pm 9.09	16.33 \pm 8.69	19.07 \pm 12.02	0.007
Environmental factors				
Noise	58 (15.06)	47 (13.54)	11 (28.95)	0.012
Light	62 (16.10)	50 (14.41)	12 (31.58)	0.006
Roommate	63 (16.25)	52 (14.99)	11 (28.95)	0.027
Animals or Insects	51 (13.25)	42 (12.10)	9 (23.68)	0.046

Abbreviations: HbA1c = Hemoglobin A1C, FBS = Fasting Blood Sugar, LDL = Low Density Lipoprotein, TG = Triglycerides

* Fisher's exact test

TABLE 2. Sleep quality among elderly with diabetes.

Sleep Quality	Total N (%) (N=385)	Good quality N (%) (N=347)	Poor quality N (%) (N=38)	P-value
n (% in row)	385 (100)	347 (90.12)	38 (9.88)	
T-PSQI mean \pm SD	2.79 \pm 2.11	2.28 \pm 1.36	7.50 \pm 1.84	<0.001
min , max	0 , 14	0 , 5	6 , 14	
Subjective sleep quality				<0.001
Very good	302 (78.44)	295 (85.01)	7 (18.42)	
Fairly good	64 (16.62)	46 (13.29)	18 (47.37)	
Fairly bad	18 (4.68)	6 (1.73)	12 (31.58)	
Very bad	1 (0.26)	0 (0)	1 (2.63)	
Sleep efficiency (%)				<0.001
≥ 85	288 (74.81)	274 (78.96)	14 (36.84)	
75-84	71 (18.44)	60 (17.29)	11 (28.95)	
65-74	19 (4.94)	11 (3.17)	8 (21.05)	
< 65	7 (1.82)	2 (0.58)	5 (13.16)	
Sleep latency (min)				0.001
≤ 15	122 (31.69)	114 (32.85)	8 (21.05)	
16-30	185 (48.05)	175 (50.43)	10 (26.32)	
31-60	74 (19.22)	58 (16.71)	16 (42.11)	
> 60	4 (1.04)	0 (0)	4 (10.53)	
Sleep duration (hr)				<0.001
> 7	331 (85.97)	314 (90.49)	17 (44.74)	
6-7	44 (11.43)	29 (8.36)	15 (39.47)	
5-6	9 (2.34)	4 (1.15)	5 (13.16)	
< 5	1 (0.26)	0 (0)	1 (2.63)	
Sleep disturbance score				<0.001
0	168 (43.64)	162 (46.69)	6 (15.79)	
1	178 (46.23)	156 (44.96)	22 (57.89)	
2	38 (9.87)	28 (8.07)	10 (26.32)	
3	1 (0.26)	1 (0.29)	0 (0)	
Have to get up to use the bathroom				0.001
Not during the past month	101 (26.23)	93 (26.80)	8 (21.50)	
Less than once a week	198 (51.43)	183 (52.74)	15 (39.47)	
Once or twice a week	80 (20.78)	68 (19.60)	12 (31.58)	
Three or more times a week	6 (1.56)	3 (0.86)	3 (7.89)	
Cannot breathe comfortably				0.001
Not during the past month	199 (51.69)	183 (52.74)	16 (42.11)	
Less than once a week	168 (43.64)	151 (43.52)	17 (44.74)	
Once or twice a week	16 (4.16)	12 (3.46)	4 (10.53)	
Three or more times a week	2 (0.52)	1 (0.29)	1 (2.63)	
Have pain				<0.001
Not during the past month	197 (51.17)	184 (53.03)	13 (34.21)	
Less than once a week	156 (40.52)	138 (39.77)	18 (47.37)	
Once or twice a week	30 (7.79)	24 (6.92)	6 (15.79)	
Three or more times a week	2 (0.52)	1 (0.29)	1 (2.63)	
Use of sleep medication				<0.001
Not during the past month	357 (92.73)	336 (96.83)	21 (55.26)	
Less than once a week	18 (4.68)	9 (2.59)	9 (23.68)	
Once or twice a week	6 (1.56)	2 (0.58)	4 (10.53)	
Three or more times a week	4 (1.04)	0 (0)	4 (10.53)	
Daytime dysfunction score				<0.001
0	296 (76.88)	287 (82.71)	9 (23.68)	
1	51 (13.25)	36 (10.37)	15 (39.47)	
2	29 (7.53)	17 (4.90)	12 (31.58)	
3	9 (2.34)	7 (2.02)	2 (5.26)	

TABLE 3. Logistic regression analysis of factors associated with poor sleep quality.

Variables	Crude OR	95% CI	P value	Adjusted OR	95% CI	P-value
Sex (female)	1.93	0.88 - 4.20	0.098	2.57	1.06 - 5.93	0.035
Age	0.93	0.87 - 1.00	0.072	0.93	0.86 - 1.00	0.050
Body mass index	1.13	1.05 - 1.23	0.002	1.09	1.00 - 1.20	0.028
Diabetic neuropathy	3.55	1.72 - 7.33	0.001	4.12	1.70 - 9.99	0.002
Diabetic retinopathy	8.04	2.06 - 31.39	0.001	6.28	1.32 - 29.94	0.021
Noise	2.90	1.49 - 5.61	0.002	1.00	0.24 - 4.58	0.947
Light	3.15	1.67 - 5.93	<0.001	3.15	0.82 - 11.24	0.080
Roommate	2.66	1.33 - 5.31	0.005	1.54	0.49 - 4.77	0.460
Animal or Insects	2.45	1.14 - 5.27	0.021	1.18	0.31 - 4.13	0.795
Energy Mobility	1.02	0.99 - 1.06	0.082	1.00	0.96 - 1.03	0.949

affect patients' sleep quality.²³ 4) The study indicated that elderly patients who have diabetic retinopathy were six times more likely to encounter poor sleep quality compare to those who did not have any complications. As previous studies^{2,24,25} poor sleep quality was associated with diabetic retinopathy. Tan NYQ et al. (2018), showed that patients who developed a short duration of sleep can affect the development of all diabetic complication such as retinopathy.²³⁻²⁵ Some studies found that other complications such as chronic wound related to poor sleep quality²⁶, however, two types of diabetic complications were associated with poor sleep quality significantly in this study. Additionally, high blood glucose level in the past could be represented to the diabetic complications despite good ranges of current laboratory results.²² This simplified that the appearance of diabetic complication or previously poor disease controlled resulted in disturbing symptoms and poor sleep quality in the present study. Nevertheless, the other underlying diseases or confounding variables such as the use of anxiolytics, antidepressants, caffeinated drink, and other metabolic abnormalities could affect the association between sleep quality, DM, and the examined factors, which should be investigated in further research.

Limitations

The cross-sectional study design of the study is a limitation as recall bias may appear. As a consequence of the low prevalence of poor sleep quality, the result in the study may be unable to generalize to other population which have different prevalence or patients' characteristic. Moreover,

the sleep quality and disturbance factors were subjectively assessed, and no clinically objective measurements were conducted, like overnight polysomnography, daytime multiple sleep latency tests, and CPAP titration studies which offered more accurate diagnosis of sleep problems and other co-morbidities such as OSAS.²⁷ The result in older population from this study may not be able to extrapolate to other age groups.

CONCLUSION

Poor sleep quality in this study was low compared with other settings. Our study showed a strong association between diabetic complications and poor sleep quality. As discussed in preceding sections, the etiology of poor sleep quality in elder patients with diabetes is usually multifactorial and multidirectional. Hence, a comprehensive history, cautious examination, complete laboratory investigations and efficacy follow-up blood glucose level²⁸ will be required for successful evaluation and subsequent management of poor sleep quality in this population. Other clinical measuring such as overnight polysomnography, multi-setting studies and longitudinal cohort design would be suggested for future research.

ACKNOWLEDGMENTS

The authors would like to thank the Research Unit of the Department of Family Medicine, Chiang Mai University, the Primary Care Unit Nurse Team of Phrae Hospital, and Ms. Pichayaporn Sunthornmuang for all assistance and support. We gratefully acknowledge all the participants who made this project possible.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contribution: All authors have made substantial contributions to conception, drafting. All authors approved the final version and agreed to be accountable for all aspects of the study.

Conflict of interest: The authors declare no conflict of interest.

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