

Sleep Quality And Type 2 Diabetes

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Abstract

Objectives: Sleep disturbances are prevalent in people with type 2 diabetes (T2DM). The aim of this study is to determine the prevalence of poor sleep quality among patients with T2DM and investigate associated factors.

Methods: This is an analytical cross-sectional design which recruited 400 patients with T2DM randomly in, Saudi Arabia. The sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). Data were collected through face-to-face interviews and reviewing participants' medical records. Logistic regression analysis was used to identify predictors of poor sleep quality in patients with T2DM.

Results: The total PSQI mean score was 7.11 ± 3.53 . The results demonstrated that about two-thirds of the patients with T2DM (64.5%) had poor sleep quality. Several factors were significantly associated with poor sleep quality, including old age ($p=0.001$), married ($p<0.001$), long duration of diabetes ($p<0.001$), daily coffee consumption ($p<0.001$), and presence of depression and anxiety symptoms ($p<0.001$). Also, the results revealed a significant positive correlation between poor sleep quality and hemoglobin (HbA1c) ($p<0.001$). HbA1c was a significant independent predictor of poor sleep quality after adjustment for age, marital status, duration of diabetes, coffee consumption, and depression, anxiety, and stress symptoms.

Conclusions: Poor sleep quality is prevalent in patients with T2DM in this Saudi. Therefore, healthcare providers should routinely identify and address sleep problems in patients with T2DM to prevent the negative impact of poor sleep quality.

Keywords: Sleep quality, T2DM, glycemic control, depression, anxiety, stress.

1. Introduction

Sleep is a fundamental physiological process that is essential for the rest of the body and a healthy lifestyle(1). The National Sleep Foundation indicates that good sleep quality includes sleeping more than 85% of the total time in bed, falling asleep in 30 minutes, and being awake for 20 minutes or less after falling asleep(2). Furthermore, according to the American Academy of Sleep Medicine, the recommended sleep duration for adults' ranges from seven to nine hours (3).

Sleep disturbance symptoms are common in the general population, especially among people with type 2 diabetes mellitus (T2DM) and obesity(4,5). Poor sleep quality may be associated with the T2DM itself or with its complications and other associated co-morbidities(6,7). T2DM can predispose to disturbed sleep patterns due to its associated symptoms, such as pain and discomfort caused by diabetes neuropathy, nocturnal polyuria, and sleep apnea, which have been proposed to contribute to T2DM-related poor sleep quality(7,8). Evidence demonstrates that the prevalence of sleep disturbances in people with T2DM ranges from 49-81%(9–15), which impairs quality of life, diabetes self-care, and glycemic control(16). There is a scarcity of data that determine the magnitude and determinants of poor sleep quality in patients with T2DM especially among Arabic population (9–14). In addition, to the best of our knowledge, the association between poor sleep and poor glycemic control in Saudi patients has not been evaluated in any prior study. Thus, the present study aims to address this gap.

2. Materials and Methods

2.1. Study Design and Setting

An analytical cross-sectional design was applied in the current study among Saudi adults with T2DM in Jeddah city. Jeddah city is located in the western region of Saudi Arabia and has a population of approximately 3,450,000 people. Its population is predominantly homogenous, with similar ethnic and socioeconomic characteristics. All patients with T2DM (414000) are registered in 48 primary health care (PHC) centers in Jeddah city (17).

2.2 Sampling Technique

The World Health Organization cluster survey design has become the method of choice in the field to measure prevalence studies of diseases(18). Therefore, a 3-stage cluster sampling technique was adopted for the sample selection in the current study and employed digital mapping for Jeddah city. In the first stage, a Jeddah city map was divided into four large clusters: north, south, west, and east. All PHC centers in each cluster were sorted and listed in a sampling frame. In the second stage, one PHC center was selected randomly from each cluster. In the third stage, all Saudi adults with T2DM were identified from the registry system database in each selected PHC center. They were then sorted and listed in an Excel spreadsheet as a sampling frame. Then, they were ordered by serial numbers, which were entered into the Stata software to randomly and proportionately select 400 participants.

2.3 Data Collection

Face-to-face interviews were held to collect data, including age, marital status, number of children under ten under their care, education level, occupation, smoking, and anthropometric measurements, such as weight, height, and body mass index (BMI). Other covariates were also accounted for, including the consumption of coffee. The variable related to disease is the duration of diabetes.

Sleep quality was assessed using a valid subjective tool called the Pittsburgh Sleep Quality Index (PSQI) (19). This index contains seven component scales: sleep disturbances, sleep duration, sleep latency, sleep efficiency, use of sleep medication, daytime dysfunction, and sleep quality. Each component is scored from 0 to 3, and the sum of the scores of the seven components ranges from 0 to 21. A patient with an overall PSQI score of > 5 is considered to have poor sleep quality.

The Depression, Anxiety, and Stress Scale (DASS) is a standardized and validated tool (20). It consists of three self-reported scales, each with seven items, used to assess the psychological states of depression, anxiety, and stress. Each item is rated on a 4-point severity scale to determine the extent to which the participant has experienced it. The scores for the relevant items are added to calculate the scores for each emotional state.

Glycated hemoglobin HbA1c provides a longer-term trend of how high your blood sugar levels have been over time, similar to an average. HbA1C was used to classify the participants as having good control diabetes with HbA1c less than or equal 7 and poor control diabetes with HbA1c more than 7 (21).

BMI was calculated as a person's weight in kilograms divided by their height in meters squared (kg/m^2) following the World Health Organization guidelines(22) . BMI is categorized as underweight for values $< 18.50 \text{ kg}/\text{m}^2$, normal for $18.50\text{--}24.99 \text{ kg}/\text{m}^2$, overweight for $25\text{--}29.99 \text{ kg}/\text{m}^2$, and obese for $\geq 30 \text{ kg}/\text{m}^2$.

2.4 Statistical Analysis

Data entry and analysis were performed using the Statistical Package for the Social Sciences® software. The data was coded with anonymous identification numbers to ensure the participants' privacy. Categorical variables were presented as percentages, while continuous variables were presented as the mean $\pm$ standard deviation (SD) for normally distributed variables and as the median (interquartile range) for non-normally distributed variables. Chi-square and Fisher's exact tests were used to assess any significant associations between the categorical variables and poor sleep quality. Correlations between two continuous variables were assessed using Pearson's correlation coefficient. The independent samples t-test and Mann-Whitney U test were used to compare the mean differences between groups of normal and non-normal variables, respectively. Logistic regression analysis was employed to identify predictors of poor sleep quality. A P-value of < 0.05 was considered statistically significant.

3. Results

A total of 400 participants were included in the study. The prevalence of poor sleep quality in our study is 64.5%. More than half of the responders were male (54.8%), while the mean age of the participants was 51 ± 9.89 . Most participants (75%) were married, and 52.3% held bachelor's degrees. About 62% were not smokers, and the same proportion reported drinking coffee. Moreover, poor sleep quality was significantly associated with marital status ($p < 0.001$) and drinking coffee ($p < 0.001$). Additionally, significant differences among sleep quality groups were detected in age ($p = 0.001$) and number of cups of coffee consumed daily ($p < 0.001$). Detailed demographic characteristics and associations with poor sleep quality are shown in Table 1.

Table 1. Demographic characteristics associated with poor sleep quality.

Characteristics	Total	Sleep Quality		P-value
		Poor(n=258)	Good(n=142)	
Age				0.001
Mean $\pm$ SD	51.34 $\pm$ 9.89	52.647 $\pm$ 9.342	48.972 $\pm$	
Gender				0.128
Male	219 (54.8%)	134 (%51.9)	85 (59.9%)	
Female	181 (45.3%)	124(%48.1)	57 (40.1%)	
Marital status				<0.001
Single	27 (6.8%)	12 (%4.7)	25 (10.6%)	
Married	300 (75%)	195 (%75.6)	105 (73.9%)	
Divorced	45 (11.3%)	24 (9.3%)	21 (14.8%)	
Widow	28 (7%)	27 (%10.5)	1 (0.7%)	
Education level				0.707
Uneducated	7 (1.8%)	3 (1.2%)	4 (2.8%)	
Primary school	7 (1.8%)	5 (1.9%)	2 (1.4%)	
Mid school	18 (4.5%)	11 (4.3%)	7 (4.9%)	
High school	125 (31.3%)	81 (31.4%)	44 (31.0%)	
Bachelor	209 (52.3 %)	133 (51.6%)	76 (53.5%)	
Postgraduate	34 (8.4%)	25 (9.7%)	9 (6.3%)	
Smoking				0.236
Yes	152 (38%)	104(40.3%)	48 (33.8%)	
No	248 (62%)	154(59.7%)	94 (66.2%)	
Employment status				0.799
Employee	204 (51%)	134 (51.9%)	70 (49.3%)	
Not employee	94 (23.5%)	58 (22.5%)	36 (25.4%)	

Retired	102 (25.5%)	66 (25.6%)	36 (25.4%)
Working hours	0.101		
Morning work	156 (76.1%)	96 (71.6%)	60 (84.5%)
Evening work	18 (8.8%)	13 (9.7%)	5 (7%)
Shift work	31 (15.1%)	25 (18.7%)	6 (8.6%)
Number of children you support	0.258		
Mean $\pm$ SD	1.29 $\pm$ 1.65	1 $\pm$ 2	1 $\pm$ 2
Drinking coffee	<0.001		
Yes	152 (38%)	156 (60.5%)	111 (78.2%)
No	248 (62%)	102 (39.5%)	31 (21.8%)
Number of cups of coffee drinks daily	<0.001		
Mean $\pm$ SD	2.16 $\pm$ 0.89	2.26 $\pm$ 0.88	1.97 $\pm$ 0.90

Regarding clinical characteristics, only 66 (16.5%) participants had a normal BMI, while 35.5% and 47.5% were classified as overweight and obese, respectively, and 64% did not exercise regularly, as shown in Table 2. Furthermore, HbA1c is found to be significantly different between sleep quality groups ($p<0.001$). Also, there was a significant difference in the duration of diabetes ($p<0.001$) as well as across psychiatric symptoms, including depression, anxiety, and stress ($p<0.001$) between sleep quality groups, as demonstrated in Table 2.

Table 2. Clinical characteristics associated with poor sleep quality.

Characteristics	Total	Sleep Quality		P-value
		Poor(n=258)	Good(n=142)	
HbA1c				<0.001
Mean $\pm$ SD	7.89 $\pm$ 1.11	8.06 $\pm$ 1.17	7.61 $\pm$ 0.96	
Duration of diabetes in years				<0.001
Mean $\pm$ SD	6.38 $\pm$ 5.53	7.36 $\pm$ 6.09	4.62 $\pm$ 3.76	
BMI				0.83

Median (Interquartile range)	29.47 (6.35)	29.69 (6.43)	29.38 (5.91)
Exercise			0.327
< 150 min a week	256 (64%)	170(65.9%)	86 (60.6%)
> 150 min a week	144 (36%)	88(34.1%)	56 (39.4%)
Anxiety score			<0.001
Mean ± SD	3.07±3.43	3.94±3.61	1.49±2.38
Depression score			<0.001
Mean ± SD	3.59±3.71	4.69±3.84	1.58±2.43
Stress score			<0.001
Mean ± SD	5.14±4.07	6.61±3.91	2.48±2.84

The PSQI scale comprised seven components, which were computed together to get the total PSQI score for each participant. The total PSQI scores ranged from 0 to 17, with a mean score of 7.11 ± 3.53 . This mean score surpasses the threshold of five, suggesting poor sleep quality. Among the study participants, 64.5% (258 individuals) were identified as having poor sleep quality. Out of the total participants, only 36 (9%) reported sleeping less than 5 hours per night. Moreover, most participants (64%) reported that it usually takes them between 16-60 minutes to fall asleep. In addition, a high portion of participants (71.3%) indicated that they do not use sleep medication to help them fall asleep. Table 2 illustrates the mean and SD for the seven components of the PSQI scale.

The associations of poor sleep quality with demographic and clinical factors are shown in Table 1. The results indicated that poor sleep quality was significantly associated with marital status ($p<0.001$), drinking coffee ($p<0.001$), and HbA1c ($p=0.006$). However, the associations of poor sleep quality with gender, education level, employment status, working hours, exercise, smoking, and BMI were not statistically significant. Furthermore, the results revealed a significant association between poor sleep quality and continuous variables, including age ($p=0.001$), number of cups of coffee consumed daily ($p<0.001$), duration of diabetes in years ($p<0.001$), HbA1c ($p<0.001$) and DASS scores ($p<0.001$).

An association was examined between the PSQI score and HbA1c using the Spearman correlation test, showing a significant positive correlation ($r=0.186$, $p<0.001$), as illustrated in Figure 1. Also, the Pearson correlation test examined the correlation between the PSQI score and various continuous variables. The results revealed a significant correlation between the PSQI score and depression, anxiety, and stress scores, with positive correlations of 0.525, 0.457, and 0.609, respectively. This suggests that individuals with poor sleep quality are more likely to experience depression, anxiety, and stress.

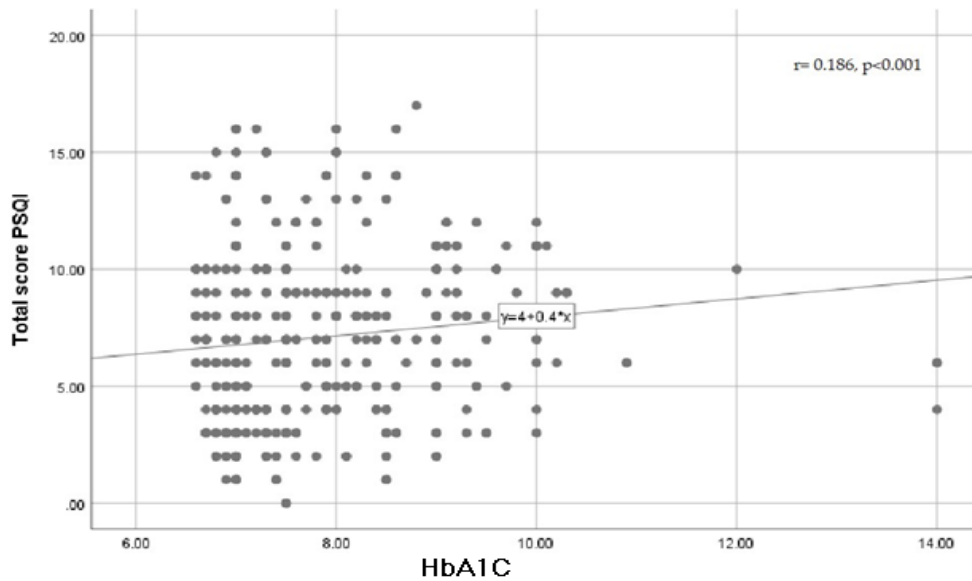


Figure 1: correlation between total score PSQI and HbA1c

Table 3 presents the results of the logistic regression analysis. The results indicate that several factors are significantly associated with poor sleep quality. These factors include marital status, coffee consumption, daily cups of coffee consumed, duration of diabetes in years, HbA1C, depression, and stress. The results showed that individuals who were married were 10fold more likely to have poor sleep quality after adjusting for several potential confounders (OR=12.584, $p = 0.038$). Additionally, the results suggest that a one-cup increase in coffee consumption results in a 45% increased likelihood of poor sleep quality (OR=1.448, $p = 0.002$). Furthermore, a one-year increase in the duration of T2DM is approximately a 12% chance of having poor sleep quality (OR= 1.118, $p=0.001$); interestingly, a one-percent rise in HbA1C has a 42% increase in odds of having poor sleep quality (OR= 1.422, $p=0.008$). Moreover, the results indicate that an increase in depression scores is 23% more likely to have poor sleep quality compared to the good sleep quality group (OR= 1.231, $p=0.006$). Also, an increase in stress score is 36% more likely to have poor sleep quality compared to the good sleep quality group (OR= 1.36, $p<0.001$).

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

Factors	Odds ratio (OR)	(CI 95%)	P-value
Marital status			
Single	17.786	(1.286-245.91)	0.032
Married	12.584	(1.146-138.14)	0.038
Divorced	23.381	(1.904-287.06)	0.014
Widow	1		

Age	1.023	(0.9891-.059)	.192
Daily cups of coffee consumed	1.448	(1.061-1.975)	0.02
Duration of diabetes in years	1.118	(1.044-1.197)	0.001
HbA1C	1.422	(1.097-1.844)	0.008
Anxiety score	0.985	(0.838-1.157)	0.850
Depression score	1.231	(1.063-1.426)	0.006
Stress score	1.360	(1.201-1.540)	<0.001

4. Discussion

Our study demonstrated that about two-thirds of patients with T2DM (64.5%) had poor sleep quality. This result is similar to a study conducted by Alamer et al., which found that 63.7% of T2DM patients had poor sleep quality(15). These findings underscore the need for action. Clinicians and health educators should focus on addressing poor sleep quality in T2DM patients, as it could be a significant factor in their dietary habits. On the other hand, Alshenghiti et al. reported that 72% of patients with T2DM had poor sleep quality. This could be due to the study's setting, as it was conducted in a specialized diabetic center that is considered as a tertiary center(13).

Furthermore, the results showed that a one-cup increase in consuming coffee has a 45% increased likelihood of having poor sleep quality (OR=1.448, $p = 0.002$). In contrast, Darraj et al. reported a non-significant association between coffee consumption and poor sleep quality(14). The authors hypothesized that the non-significant result may be attributed to eliminating drinks containing caffeine several hours before bedtime. This was not examined in their study; however, in reality, coffee consumption has tangible effects on sleep(23).

The current study's result showed a non-significant association between smoking and poor sleep quality. This finding is consistent with a study conducted by Alshenghiti et al.(13). However, Darraj et al. reported a significant association between smoking and poor sleep quality. Interestingly, they also found a significant association between khat chewing and poor sleep quality(14). Khat chewing could be a precursor for smoking, as illustrated by Kassim et al.(24). Thus, affecting sleep quality negatively.

The findings demonstrated a significant positive correlation between the PSQI score and HbA1c ($r=0.186$, $p<0.001$). This finding was in contrast to Alamer et al., in which the correlation between PSQI and HbA1C was non-significant. This can be attributed to obtaining HbA1C levels; we obtained the last HbA1c reading from the medical record, whereas Alamer et al. acquired this information from the participants themselves(15). Additionally, the PSQI score and the scores for depression, anxiety, and stress showed positive correlations of 0.525, 0.457, and 0.609, respectively. This implies that individuals with lower sleep quality are at a higher risk of experiencing depression, anxiety, and stress.

The results indicated that individuals who were married were 10fold more likely to have poor sleep quality after adjusting for several potential confounders, which was statistically significant (p -

value=0.038). This result aligns with a study that concluded married individuals had poor sleep quality compared to divorced or widowed individuals (25). On the contrary, Alamer et al. and Darraj et al. found a non-significant association between poor sleep and marital status(14,15).

Poor sleep quality was higher among patients with psychiatric symptoms such as depression, anxiety, and stress. This finding is consistent with the results reported in a study conducted by Darraj et al. (14). The similarity in findings could be attributed to the population sampling frame, as both studies were conducted in a PHC center setting.

Our study had some limitations. For instance, the adopted study design cannot demonstrate a temporal relationship between patients with T2DM and poor sleep quality. Also, our study findings can only be applied to T2DM patients in Jeddah city and generalizability of the results would be inappropriate.

Overall, this research study highlights various factors associated with poor sleep quality experienced by individuals with T2DM. Conducting multicenter longitudinal studies might assist in exploring and understanding these factors, which could be instrumental in creating effective interventions to enhance the sleep quality of patients with T2DM.

5. Conclusions

Poor sleep quality among patients with T2DM is a prevalent health problem. This study aimed to assess the sleep quality among patients with T2DM in Jeddah, Saudi Arabia, and identify potential risk factors. The results revealed that a significant majority of the participants (64.5%) had poor sleep quality. Several factors were significantly associated with poor sleep quality, including being married, increasing cups of coffee consumed, increasing HbA1c, increasing age, long duration of diabetes, and increasing DASS scores. Based on the study findings, it is important for healthcare providers to routinely identify and address sleep problems in patients with diabetes to prevent the negative impact of poor sleep quality.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of General Directorate of Health Affairs in Jeddah (A01774).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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