Original Article

Effects of diabetes mellitus complications on sleep quality among Saudi Arabian patients-A national study

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Abstract

Introduction: In diabetes mellitus (DM) patients, obtaining a good night's sleep is crucial for maintaining body caloric intake, controlling insulin levels, and reducing the likelihood of engaging in unhealthy behavior. Patients with poor sleep quality may experience impaired glycemia, playing a significant role in the development of chronic complications. This study aims to explore the effects of DM complications on sleep quality among Saudi Arabian patients. **Patient and Methods:** This is a cross-sectional study conducted among patients with diabetes. A self-administered, validated questionnaire translated into Arabic was distributed among diabetic patients using an online survey. The questionnaire includes sociodemographic characteristics (i.e. age, gender, marital status, etc.), the medical history of the patients, and a questionnaire about sleep quality. **Results:** Out of 4171 patients involved, 52.7% were females and 27.7% were aged between 40 and 60 years old. The prevalence of patients with perceived poor sleep quality was 24.1%. Significant predictors of poor sleep quality were the gender female, having social stressors, comorbid sleep disorders, associated comorbidities, increasing HbA1c levels, being overweight/obese, and diabetes complications. Furthermore, sleep disturbance, taking sleep medications, daytime sleepiness, and having bad dreams during sleep were also identified as prognostic factors for poor sleep quality. **Conclusion:** The subjective poor sleep quality of patients with diabetes was 24.1%. Poor sleep quality was significantly demonstrated by females who were having social stressors, comorbid sleep disorders, comorbidities, uncontrolled HbA1c levels, elevated BMI levels, and complications of diabetes. However, regular physical activity and adequate sleep were estimated to be the protective factors against poor sleep quality. Further research is needed to establish the effect of sleep quality among patients with DM.

Keywords: Complication, diabetes mellitus, sleep quality

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Introduction

Diabetes mellitus (DM) can be defined as a group of metabolic complaints described by hyperglycemia resulting from deficiencies in insulin secretion, action, or both.[1] Diabetes mellitus is

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considered one of the highest global health emergencies of the twenty-first century, according to the International Diabetes Federation.[2] The Kingdom of Saudi Arabia is among the countries with the highest prevalence of DM, as 23.1% of the population suffer from the disease.[3] Recent research in Saudi Arabia suggested that more than 44% of individuals aged 55 or older had severe uncontrolled diabetes with long-term complications.[2] Uncontrolled DM results in microvascular and macrovascular complications. These complications not only cause increased morbidity but life-threatening impediments as well. Diabetes control and complication trial found that intensive glycemic control could prevent or slow the progression of diabetic complications.[4] SLEEP is an active biologic function that is essential for life and is critical for physical, mental, and emotional well-being. Any defects in sleep quality and quantity may lead to several complications, including metabolic errors.[5] In DM patients, getting a good night's sleep is crucial for maintaining body caloric intake, controlling insulin levels, and reducing the likelihood of engaging in unhealthy behavior.[6] Patients having poor quality of sleep can have chances of impaired glycemia hence, play a significant role in the development of chronic complications.[4] According to the available data, patients with DM frequently experience problems with poor sleep quality. Globally, poor sleep quality has an impact on 47.6% of diabetes. In Africa, 29.5 percent of diabetics reported having sleep problems. According to a study conducted in Ethiopia, approximately 55.6% of diabetic patients experienced sleep disturbances.[6] The sleep complaints are often related to the presence of underlying sleep-disordered breathing, nocturia, physical complications of diabetes, and underlying depression.[5] Diabetes mellitus and sleep are reported to have bidirectional association. As many researchers have documented that diabetes affects the patient's sleep quality negatively and also an imbalance in sleep quality considerably influences the adequacy of glycemic control, which in turn can have a harmful effect on patient's health-related quality of life.[7] Diabetes mellitus in addition to causing direct sleep disturbances has also been associated with several chronic illnesses which can impair sleep and quality of life.[4]

Methodology

A descriptive cross-sectional questionnaire-based study was conducted in Saudi Arabia between August 2022 and October 2022. The target population was the general population of patients with diabetes from different regions (Central, Southern, Eastern, Western, and Northern). The data was gathered via a validated, self-administered questionnaire. The survey was distributed electronically using Google Forms (Google LLC, Mountain View, CA, USA). The data were entered into Microsoft Excel (Microsoft Corp., Redmond, WA, USA), and then uploaded and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Armonk, NY: IBM Corp.

A panel of three experts reviewed the questionnaire items in context with the study objectives to assess their content validity. The assessment was first done independently, and then items with debates were discussed in detail until there was consensus. All suggested modifications were applied to improve the validity of the questionnaire until the final format used in the current study was obtained.

Reliability

The questionnaire showed a satisfactory level of reliability with a Cronbach's Alpha coefficient for scale data of 0.76. (8, 9) Removing any of the questionnaire items will not improve the questionnaire reliability (all post-removal Cronbach's Alpha are below the overall estimated 0.76 level), so all items should be kept.

The questionnaire was uploaded to Google Forms and then distributed online via 100 trained data collectors from different regions of the Kingdom of Saudi Arabia. The study's data were collected between August 2022 and October 2022 via social networking apps such as WhatsApp groups, Facebook groups, Twitter, Instagram, and LinkedIn.

The single criterion for selecting respondents was having DM. Thus, those who did not have DM were excluded. Additionally, those who are prediabetic are also excluded. Also, uncompleted responses were excluded.

Participation in this study was fully voluntary and optional, with informed consent offered to all participants on the first page before completing the questionnaire. All information was kept private and was solely utilized for scientific research. The Ethics Committee of the Southern Region Armed Force Hospital (AFHSRMREC/2022/FAMILY MEDICINE/641) granted ethical approval.

Statistical analysis

Patients' sleep quality has been measured by asking patients their perceived sleep quality wherein "very good" and "fairly good" were grouped as good sleep quality, and "fairly bad" and "very bad" were grouped as poor sleep quality.

The data were analyzed using SPSS version 26 Armonk, NY: IBM Corp. Both descriptive and inferential statistics had been conducted. All categorical variables were presented as numbers and percentages. A *P* value cut-off point of 0.05 at 95% Confidence interval (CI) was considered statistical significance. Subjects were grouped in order according to relevance. Univariate and multivariate analyzes were performed to determine the effect of poor sleep quality according to the sociodemographic characteristics, medical history, and sleep quality of the diabetic patients with corresponding odds ratios as well as a 95% confidence interval.[8-9]

Results

In total, 4171 diabetic patients were involved. Table 1 presented the sociodemographic characteristics of the patients. The most common age group was 40–60 years old with more than

half being females (52.7%). The majority (62.3%) were living in the city and 34% came from the Western Region. Patients with bachelor's degrees constitute 56.7% and those who were employed constitute 42%. With respect to marital status, 56.5% were married. Most of the patients were living with family (92.2%). The proportion of smoking patients was 15.5% while those who drink alcohol were 1.9%. The prevalence of patients with social stressors was 39.6%. The 70.7% were coffee drinkers whereas three-quarters (75.2%) were actively engaged in physical activity.

Table 1: Sociodemographic characteristics of the patient with diabetes (*n*=4171)

Study data	*n* (%)
Age group	
<20 years	567 (13.6%)
20–25 years	632 (15.2%)
26–30 years	448 (10.7%)
31–35 years	385 (09.2%)
36–40 years	511 (12.3%)
40–60 years	1155 (27.7%)
>60 years	473 (11.3%)
Gender	
Male	1971 (47.3%)
Female	2200 (52.7%)
Residence location	
Urban	2597 (62.3%)
Rural	1574 (37.7%)
Region of residence	
Central Region	1126 (27.0%)
Eastern Region	650 (15.6%)
Southern Region	422 (10.1%)
Northern Region	555 (13.3%)
Western Region	1418 (34.0%)
Educational level	
High school or below	1807 (43.3%)
Bachelor's degree	2364 (56.7%)
Employment status	
Employed	1753 (42.0%)
Unemployed	2418 (58.0%)
Marital status	
Single	1493 (35.8%)
Married	2355 (56.5%)
Divorced or widowed	323 (07.7%)
Living status	
Living alone	257 (06.2%)
Living with family	3846 (92.2%)
Living with non-family	68 (01.6%)
Smoking status	
Smoker	646 (15.5%)
Non-smoker	3134 (75.1%)
Ex-smoker	391 (09.4%)
Drinking alcohol	
Yes	80 (01.9%)
No	4091 (98.1%)
Having social stressor	
Yes	1651 (39.6%)
No	2520 (60.4%)
Are you a Coffee, tea, or any caffeine products lover?	
Yes	2947 (70.7%)
No	1224 (29.3%)
What is your physical activity level	
Active	3138 (75.2%)
Inactive	1033 (24.8%)

Regarding the medical history of the patients [Table 2], the most common type of diabetes was type 2 (48.3%). The 22.6% of the patients had a DM duration of 6–10 years. Approximately, 45.6% had an HbA1c level of 7–10%. The most common treatment method was insulin (36.2%). In addition, 29.2% of the patients were recognized as obese.

In Figure 1, based on multiple response answers, the most common comorbid sleep disorder was insomnia (34.2%), followed by snoring (22.9%) and restless legs syndrome (12.1%).

In Figure 2, multiple response answers indicated that the most commonly known associated comorbidity of diabetic patients was hypertension (26%), followed by hyperlipidemia (24.5%) and anxiety (16.7%).

In Figure 3, the most frequently mentioned complication was retinopathy (11.5%) and diabetes foot (11.5%).

In Figure 4, it was observed that 38.7% of the patients had three or more times a week of waking up in the middle of the night or early morning, and 38.5% reported getting up to use the bathroom three times or more a week. Only 12% reported having three times or more per week of bad dreams during sleep and only 11% indicated having pain during sleep for the same duration.

Table 3 assessed the patients' sleep quality. According to our results, more than one-third (35.7%) of the patients reported having a sleep latency of 16–30 minutes. 33% indicated sleeping hours duration of 6 to 7 hours. Habitual sleep efficiency was 75–84% reported by 32.7%. Approximately, 30% indicated sleep disturbance 2 times or more a week while 2.8% indicated taking

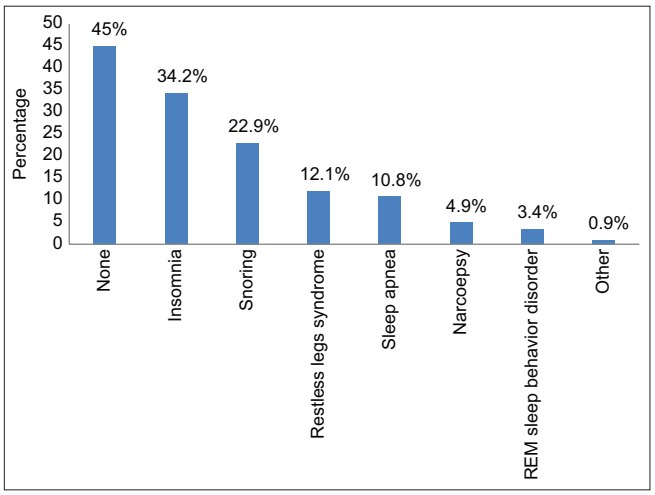

Figure 1: Patients with comorbid sleep disorders

sleep medication 3 times or more per week. Daytime sleepiness of 3 times or more per week was reported by 21.4%. Of those who experienced daytime sleepiness, the most common situation was falling asleep while resting in the afternoon (42.6%) and falling asleep while watching TV (39.3%). The majority (61.5%) reported taking a daytime nap. Overall, 58.5% perceived their sleep quality as fairly good.

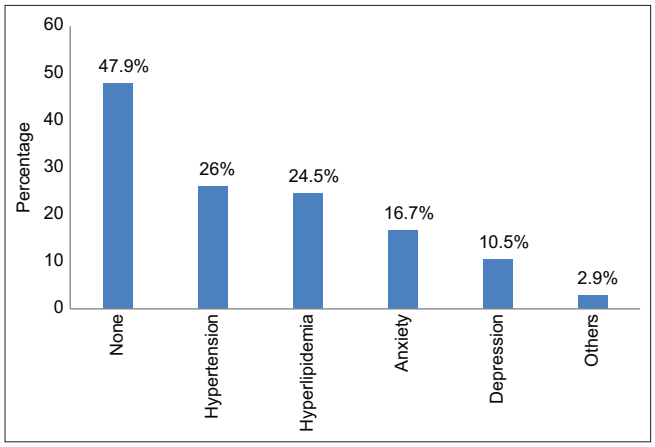

Figure 2: Associated comorbidities of the patients with diabetes

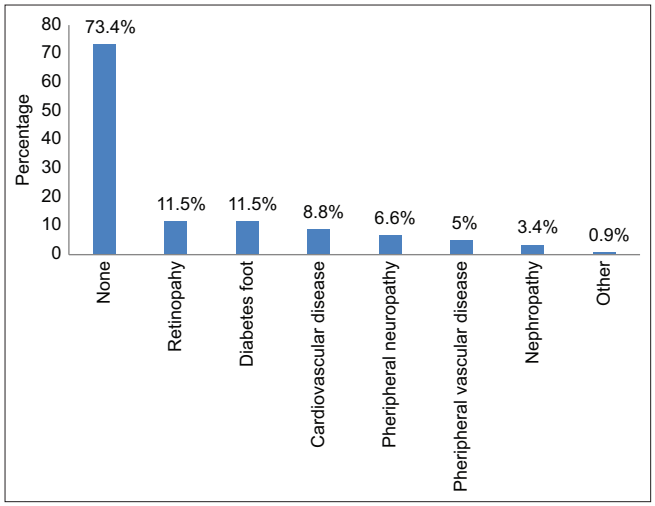

Figure 3: Complications of diabetic patients

When measuring the influence of sleep quality in terms of the sociodemographic and medical history of diabetic patients [Table 4], it was observed that gender female, having social stressors, comorbid sleep disorder, associated comorbidities, increasing HbA1c levels, overweight or obese, and having diabetes complications were the independent significant predictors of poor sleep quality while increasing age and being active in physical activity were the independent significant factors of good sleep quality. This further indicates that compared to gender males, the odds of having poor sleep quality in gender females were predicted to increase by at least 1.26 times higher (Adjusted odds ratio (AOR) =1.258;

Table 2: Medical history of the diabetic patients (*n*=4171)

Variables	*n* (%)
Type of diabetes (DM)	
Type 1 DM	1864 (44.7%)
Type 2 DM	2014 (48.3%)
Gestational DM	293 (07.0%)
Duration of DM	
<1 year	619 (14.8%)
1–3 years	643 (15.4%)
4–5 years	662 (15.9%)
6–10 years	942 (22.6%)
11–20 years	864 (20.7%)
>20 years	441 (10.6%)
HbA1c level	
<7%	1089 (26.1%)
7–10%	1901 (45.6%)
>10%	374 (09.0%)
I don't know	807 (19.3%)
Treatment method	
Diet	593 (14.2%)
OHA monotherapy	761 (18.2%)
OHA polytherapy	812 (19.5%)
Insulin	1508 (36.2%)
OHA plus insulin	497 (11.9%)
BMI level	
Underweight (<18.5 kg/m^2)	253 (06.1%)
Normal (18.5–24.9 kg/m^2)	1438 (34.5%)
Overweight (25–29.9 kg/m^2)	1263 (30.3%)
Obese (≥30 kg/m^2)	1217 (29.2%)

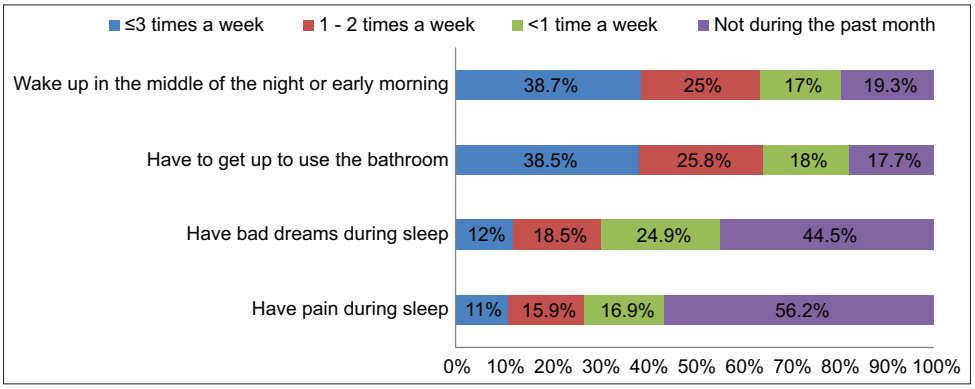

Figure 4: Frequency of sleep interruptions during the past month

Table 3: Patients' sleep quality (*n*=4171)

Variables	*n* (%)
Sleep latency (Duration in minutes to fall asleep each night)	
0–15 min	911 (21.8%)
16–30 min	1487 (35.7%)
31–60 min	1203 (28.8%)
>60 minu	570 (13.7%)
Sleep duration (hours of actual sleep at night)	
>7 h	1091 (26.2%)
6–7 h	1376 (33.0%)
5–6 h	1034 (24.8%)
<5 h	670 (16.1%)
Habitual sleep efficiency	
≥85%	955 (22.9%)
75–84%	1364 (32.7%)
65–74%	1042 (25.0%)
<65%	810 (19.4%)
Sleep disturbance	
Never	1626 (39.0%)
1 time a week	1298 (31.1%)
≥2 times a week	1247 (29.9%)
Do you use sleep medication	
Never	3386 (81.2%)
Once a week	331 (07.9%)
2 times a week	336 (08.1%)
3 times a week or more	118 (02.8%)
Daytime sleepiness (Difficulty staying awake or alert, or an increased desire to sleep during the day)	
No problem	1380 (33.0%)
Yes, 1– 2 times a week	1900 (45.6%)
Yes, ≥3 times a week	891 (21.4%)
If yes, have you been exposed to any of the following? (*n*=2791)†	
No	435 (15.6%)
Falling asleep while resting in the afternoon	1188 (42.6%)
Falling asleep while watching TV	1098 (39.3%)
Falling asleep while sitting inactive	960 (34.4%)
Falling asleep while sitting quietly after lunch	919 (32.9%)
Falling asleep while reading	722 (25.9%)
Falling asleep while traveling	673 (24.1%)
Falling asleep while sitting and talking to someone	280 (10.0%)
Falling asleep in a car while stopped in traffic	172 (06.2%)
Do you take a daytime nap?	
Yes	2567 (61.5%)
No	1604 (38.5%)
How do you evaluate your sleep quality?	
Very good	728 (17.5%)
Fairly good	2438 (58.5%)
Fairly bad	767 (18.4%)
Very bad	238 (05.7%)

†Variable with multiple response answers

95% CI = 1.026–1.542; $P = 0.027$). Patients who were having social stressors were predicted to increase the chance of having poor sleep quality by at least 1.25-fold higher compared to those with having social stressors (AOR = 1.250; 95% CI = 1.046–1.494; $P = 0.014$). Patients with comorbid sleep disorders were 4.13 times more likely to exhibit poor sleep quality compared to patients without having it (AOR = 4.129; 95% CI = 3.299–5.169; $P < 0.001$). Also, patients with associated comorbidities were 1.51-fold higher to be more associated with poor sleep quality (AOR = 1.510; 95% CI = 1.219–1.869; $P < 0.001$). Increasing HbA1c levels were more associated with increased odds of having poor sleep quality with 1.37-fold higher for patients with 7–10% HbA1c levels (AOR = 1.373; 95% CI = 1.021–1.848; $P = 0.036$) and 1.36 times higher for patients with more than 10% HbA1c levels (AOR = 1.040–1.764; $P = 0.024$). Patients with diabetes complications were predicted to increase the risk of having poor sleep quality by at least 1.76 times higher (AOR = 1.764; 95% CI = 1.446–2.151; $P < 0.001$). In contrast, we observed that increasing age was more associated with decreased risk of having poor sleep quality with 41% decreased risk for patients aged between 26 and 40 (AOR = 0.586; 95% CI = 0.440–0.779; $P < 0.001$) and 33% decreased risk for patients aged more than 40 years old (AOR = 0.669; 95% CI = 0.533–0.840; $P = 0.001$). Similarly, patients who were active in physical activity were predicted to decrease the risk of having sleep quality by at least 33% compared to those who were inactive (AOR = 0.669; 95% CI = 0.550–0.813; $P < 0.001$).

When measuring the association between the perceived sleep quality in terms of patients' sleep interruptions [Table 5], it was found that having a sleep disturbance, taking sleep medications, experiencing daytime sleepiness, and having bad dreams during sleep were the independent significant predictors of poor sleep quality while sleep latency of more than 30 minutes, sleep duration of more than 6 hours and habitual sleep efficiency of less than 75% were the independent significant predictors of good sleep quality. This further suggests that compared to patients without sleep disturbance, patients who were having sleep disturbance were predicted to increase the risk of having poor sleep quality by at least 2.75 times higher (AOR = 2.749; 95% CI = 1.921–3.935; $P < 0.001$). Patients who were taking sleep medication were 1.65 times more likely to exhibit poor sleep quality (AOR = 1.646; 95% CI = 1.067–2.540; $P = 0.024$). Patients who were having daytime sleepiness were 2.35 times more likely to be more associated with poor sleep quality (AOR = 2.350; 95% CI = 1.904–3.689; $P < 0.001$) while patients who were experiencing bad dreams during sleep were 1.91% times higher to be more associated with having poor sleep quality. On the other hand, compared to patients with a sleep latency of 30 minutes or less, patients with a sleep latency of more than 30 minutes were predicted to decrease the risk of having poor sleep quality by at least 46% (AOR = 0.536; 95% CI = 0.395–0.726; $P < 0.001$). Compared to patients with a shorter duration of sleep (≤6 hours), the risk of having poor sleep quality for patients who had a longer duration of sleep (>6 hours) was estimated to decrease by at least 54% (AOR = 0.463; 95% CI = 0.340–0.630; $P < 0.001$) while patients who had less than 75% of habitual sleep efficiency were also estimated to decrease the risk of having poor sleep quality by at least 76% (AOR = 0.241; 95% CI = 0.174–0.333; $P < 0.001$).

Table 4: Univariate and multivariate analysis for the factors that influence sleep quality (*n*=4171)

Factor	Sleep Quality		AOR (95% CI)	*P*
	Poor *n* (%) (*n*=1005)	Good *n* (%) (*n*=3166)		
Age group				
≤25 years	239 (23.8%)	960 (30.3%)	Ref	
26–40 years	358 (35.6%)	986 (31.1%)	0.586 (0.440–0.779)	<0.001**
>40 years	408 (40.6%)	1220 (38.5%)	0.669 (0.533–0.840)	0.001**
Gender				
Male	446 (44.4%)	1525 (48.2%)	Ref	
Female	559 (55.6%)	1641 (51.8%)	1.258 (1.026–1.542)	0.027**
Employment status				
Employed	429 (42.7%)	1324 (41.8%)	Ref	
Unemployed	576 (57.3%)	1842 (58.2%)	0.990 (0.812–1.207)	0.922
Smoking status				
Smoker/Ex-smoker	293 (29.2%)	744 (23.5%)	Ref	
Non-smoker	712 (70.8%)	2422 (76.5%)	0.835 (0.671–1.038)	0.104
Having social stressor				
No	507 (50.4%)	2013 (63.6%)	Ref	
Yes	498 (49.6%)	1153 (36.4%)	1.250 (1.046–1.494)	0.014**
What is your PA level?				
Active	352 (35.0%)	681 (21.5%)	0.669 (0.550–0.813)	<0.001**
Inactive	653 (65.0%)	2485 (78.5%)	Ref	
Comorbid sleep disorder				
No	182 (18.1%)	1697 (53.6%)	Ref	
Yes	823 (81.9%)	1469 (46.4%)	4.129 (3.299–5.169)	<0.001**
Associated comorbidities				
No	286 (28.5%)	1710 (54.0%)	Ref	
Yes	719 (71.5%)	1456 (46.0%)	1.510 (1.219–1.869)	<0.001**
Type of diabetes (DM)				
Type 1 DM	385 (38.3%)	1479 (46.7%)	Ref	
Type 2 DM	551 (54.8%)	1463 (46.2%)	1.070 (0.695–1.646)	0.759
Gestational DM			1.060 (0.396–1.616)	0.786
Duration of DM				
≤5 years	418 (41.6%)	1506 (47.6%)	Ref	
6–10 years	231 (23.0%)	711 (22.5%)	0.973 (0.778–1.216)	0.807
>10 years	356 (35.4%)	949 (30.0%)	0.950 (0.751–1.201)	0.667
HbA1c level				
<7%	216 (26.4%)	873 (34.3%)	Ref	
7–10%	468 (57.2%)	1433 (56.3%)	1.373 (1.021–1.848)	0.036**
>10%	134 (16.4%)	240 (09.4%)	1.355 (1.040–1.764)	0.024**
BMI level				
Normal or underweight	575 (59.5%)	2126 (72.0%)	Ref	
Overweight or Obese	391 (40.5%)	826 (28.0%)	1.514 (1.249–1.836)	<0.001**
Diabetes complication				
No	570 (56.7%)	2490 (78.6%)	Ref	
Yes	435 (43.3%)	676 (21.4%)	1.764 (1.446–2.151)	<0.001**

AOR – Adjusted Odds Ratio; CI – Confidence Interval; PA – Physical Activity; BMI - Body Mass Index; DM – Diabetes Mellitus. **Significant at *P*<0.05 level

Discussion

This study investigated the effect of diabetes complications on sleep quality among diabetic patients living in Saudi Arabia. The findings of this study revealed that among 4171 diabetic patients, 24.1% of them considered themselves as having poor sleep quality. This finding is nearly consistent with the study conducted in Taif.[2] They found that the prevalence of patients with poor sleep quality was 41.1%. However, several papers documented a high prevalence of poor sleep quality among diabetic patients ranging from 47% to 72%.[4,5,7,10–12] Most of these papers determined the sleep quality index objectively utilizing validated questionnaires while in our study the overall sleep quality of the patients was measured subjectively by asking the overall sleep quality of the patients. Consistent with this method, subjective sleep quality measures had also been employed among diabetic patients which were carried out in Nepal,[13] and Pakistan.[14] Although, this may potentially influence biases, however, there are also advantages to using them such as suitability for larger sample sizes, affordability, flexible means of implementation, and ease of use.[15]

Table 5: Univariate and multivariate analysis for the association between the perceived sleep quality and patients' sleep interruptions (*n*=4171)

Factor	Sleep Quality		AOR (95% CI)	*P*
	Poor *n* (%) (*n*=1005)	Good *n* (%) (*n*=3166)		
Sleep latency				
≤30 min	660 (65.7%)	1113 (35.2%)	Ref	
>30 min	345 (34.3%)	2053 (64.8%)	0.536 (0.395–0.726)	<0.001**
Sleep duration				
≤6 h	638 (63.5%)	1066 (33.7%)	Ref	
>6 h	367 (36.5%)	2100 (66.3%)	0.463 (0.340–0.630)	<0.001**
Habitual sleep efficiency				
≥75%	767 (76.3%)	1085 (34.3%)	Ref	
<75%	238 (23.7%)	2081 (65.7%)	0.241 (0.174–0.333)	<0.001**
Sleep disturbance				
No	137 (18.6%)	1489 (69.6%)	Ref	
Yes	598 (81.4%)	649 (30.4%)	2.749 (1.921–3.935)	<0.001**
Do you use sleep medication				
No	670 (76.0%)	2716 (91.8%)	Ref	
Yes	211 (24.0%)	243 (08.2%)	1.646 (1.067–2.540)	0.024**
Daytime sleepiness				
No	175 (31.3%)	1205 (70.4%)	Ref	
Yes	385 (68.8%)	506 (29.6%)	2.350 (1.904–3.689)	<0.001**
Wake up in the middle of the night or early morning				
No	105 (10.4%)	699 (22.1%)	Ref	
Yes	900 (89.6%)	2467 (77.9%)	0.661 (0.424–1.032)	0.069
Get up to use the bathroom				
No	118 (11.7%)	619 (19.6%)	Ref	
Yes	887 (88.3%)	2547 (80.4%)	0.753 (0.491–1.154)	0.193
Have bad dreams during sleep				
No	270 (26.9%)	1587 (50.1%)	Ref	
Yes	735 (73.1%)	1579 (49.9%)	1.908 (1.383–2.633)	<0.001**
Have pain during sleep				
No	358 (35.6%)	1986 (62.7%)	Ref	
Yes	647 (64.4%)	1180 (37.3%)	1.304 (0.943–1.802)	0.108
Do you take a daytime nap?				
No	399 (39.7%)	1205 (38.1%)	Ref	
Yes	606 (60.3%)	1961 (61.9%)	0.767 (0.566–1.040)	0.088

AOR – Adjusted Odds Ratio; CI – Confidence Interval. **Significant at *P*<0.05 level

Data in our study indicates that poor sleep quality was significantly associated with comorbid sleep disorders, associated comorbidities, poor glycaemic control, and elevated body mass index. These findings are almost in accordance with the paper of Barakat *et al.*[1] According to their reports, there was a significant correlation observed between worse glycaemic control in terms of poor sleep quality and less-efficient sleep among type 2 DM patients. This has been concurred by the study of Birhanu *et al.*,[6] wherein smoking, alcohol drinking, comorbidities, higher BMI, type 2 DM, poor glycemic control, and depression were the factors that influence poor sleep quality. However, in a study by Al Nefaie *et al.*,[2] they found no significant association between sleep quality and poor glycaemic control which did not coincide with previous reports. Furthermore, our results did not find significant differences between sleep quality in relation to the type of diabetes and its duration which contradicted the reports of Khakurel *et al.*,[13] wherein DM duration and the type of treatment were linked to subjective poor sleep quality.

In terms of sociodemographic variables, we revealed that gender females and social stressors were identified as the prognostic factors for poor sleep quality while increasing age and being engaged in physical activity were ascertained as the protective factors against poor sleep quality. This contradicted the results of a study done in India.[7] Based on their multivariate regression model, they observed that an increased risk of poor sleep quality was more associated with increasing age, male gender, and combination of insulin with Oral hypoglycemic agents (OHA) therapy while in a study done in Egypt,[5] sleep quality in patients with diabetes did not show significant differences in terms of age and gender.

Moreover, we discovered that the prevalence of patients who experience a complication of diabetes was 26.6% and based on our regression estimates, patients with DM complications were 1.76 times more likely to exhibit poor sleep quality compared to patients without DM complications. Likewise, we noted

that the most debilitating complication of diabetes was DM retinopathy, followed by DM foot (11.5%), and cardiovascular disease (8.8%). Other identified complications were peripheral vascular disease (5%) and DM nephropathy (3.4%). In India,[7] DM neuropathy was the strongest predictor of poor sleep quality while in Iran,[16] the prevalence of diabetic poor sleeper patients was significantly higher among those who were diagnosed with the presence of DM-related complications which was consistent with our reports. More investigations are warranted to determine the true effect of sleep quality among diabetic patients who were identified with the complication of diabetes.

Conversely, we came to know that 35.7% of diabetic patients had a 16–30-minutes sleep latency, and one-third of them had a regular sleep duration at night of 6–7 hours. Regarding habitual sleep efficiency, only 22.9% reported 85% or more having sleep efficiency while 39% indicated that they do not have sleep disturbance. Most of the diabetic patients (81.2%) never use sleep medication whereas approximately 67% raised concerns about daytime sleepiness with falling asleep while resting in the afternoon (42.6%), falling asleep while sitting idle (39.3%), and falling asleep while traveling (34.4%) being the most common consequences for daytime sleepiness. Notwithstanding these reports, daytime naps were also seen in most of the patients (61.5%). This scenario was comparable to that of Campos-Romero *et al.*[10] Based on their accounts, more than half (54.7%) took up to 30 minutes to get to sleep with a notable 33.2% taking longer than one hour. They further added that during the last month, 17.9% of patients took sedatives/sleeping pills, and among them, 12.5% took between one to 3 times per week.

Incidentally, we identified sleep disturbance, taking sleep medication, daytime sleepiness, and having bad dreams during sleep as predictive factors for poor sleep quality while longer sleep latency, longer sleep duration, and lower habitual sleep efficiency were identified as the protective factors. In Tabuk,[3] they reported that chronic sleep deprivation and daytime sleepiness are both common in patients with diabetes and are estimated to have a greater influence on poor DM control. However, in China,[11] they recognized sleep latency, sleep disturbance, and daytime dysfunction as the most common risk factors for poor glycaemic control. Important measures to prevent sleep deprivation among diabetic patients are imperative.

Regarding sleep disruptions, we found that more patients complained about waking up in the middle of the night or early morning with a frequency of 3 times or more a week (38.7%), 38.5% of them also complained about getting up to use the bathroom on the same frequency while complained of bad dreams (12%) and pain during sleep (11%) on the same frequency were less. This scenario had also been observed by Mehrdad *et al.*,[16] wherein they discovered that the most prevalent factors of sleep interruptions were "waking up to use a bathroom," "feeling hot," "pain," "having coughs or snores," and "bad dreams."

Limitations

We identify some study limitations in our study. First, the main outcome has been measured subjectively which could be a potential to influence bias. Second, the survey was done using online questionnaires which may be prone to errors and dishonesty among study participants. Finally, being a cross-sectional study does not help to identify the cause and effect of the study outcome.

Conclusion

The subjective poor sleep quality of patients with diabetes was 24.1%. Poor sleep quality was significantly demonstrated by females who were having social stressors, comorbid sleep disorders, comorbidities, uncontrolled HbA1c levels, elevated body mass index (BMI) levels, and complications of diabetes. However, regular physical activity and adequate sleep were estimated to be the protective factors against poor sleep quality. Continuous monitoring regarding the sleep quality of diabetic patients and appropriate interventions are vital. Reducing sleep disruptions could lead to positive diabetes outcomes. Further research is needed to establish the effect of sleep quality in terms of patients' disease progression. A prospective-multicenter study may provide better insights regarding the effect of sleep quality in patients with underlying diseases including DM.

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Conflicts of interest

There are no conflicts of interest.

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