

Sleep Disturbance among Type II Diabetic Patients and Influence of Glycemic Control

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Abstract

Background: Experimental and observational studies have indicated that poor sleep quantity and quality are associated with an increased risk of chronic diseases including insulin resistance. Additionally, sleep disorders have been reported to aggravate diabetes due to decreased glucose metabolism and elevated cortisol levels as well as it can increase the risk for the development of diabetes. Objectives: To assess the sleep quality and its determinants and impact on glycemic control of type II diabetic patients. **Methods:** A cross sectional study was adopted among a representative sample of patients diagnosed with type II Diabetes seen in Prince Mansour Military Hospital Diabetic Center in Taif throughout the study period (March-July 2021). A self-administered questionnaire was utilized in the present study including 5 main parts: demographic data of the patients, medical and social history, the Pittsburgh Sleep Quality Index (PSQI) to assess the subjective sleep quality, weight and height measurements and the most recent glycated hemoglobin (HbA1c) level. **Results:** The study included 270 type II diabetic patients out of a targeted 282 with a response rate of 95.7%. Most of them aged either between 51 and 60 years (34.8%) or over 60 years (42%). Females represent 63% of them. Majority of patients (87.8%) had HbA1c $\geq 7\%$, indicating uncontrolled blood glucose levels. Overall, poor sleep quality, based on PSQI was observed among 41.1% of type II diabetic patients. Results of multivariate logistic regression analysis revealed that compared to patients whose income was lower than 5000 SR/month, those with income of 50,001 - 1000 and >15,000 SR/month were at lower significant risk for having poor sleep (Adjusted odds ratio "AOR" = 0.44, 95% confidence interval "CI" = 0.22 - 0.86, p = 0.016 and AOR = 0.21, 95% CI = 0.06 - 0.77, p = 0.019; respectively). Opposed to diabetic patients with a duration of less than one year of DM, those with a duration ex-

ceeding 10 years were at almost 6-folds higher risk for poor sleep quality (AOR = 6.39, 95% CI = 1.12 - 36.43, $p = 0.037$). Patients with a history of social stressors were at a higher significant risk for poor sleep quality compared to those without such a history (AOR = 4.99, 95% CI = 1.71 - 14.67, $p = 0.003$). **Conclusion:** A considerable proportion of type II diabetic patients attending the diabetic center, Prince Manasour Military hospital in Taif, Kingdom of Saudi Arabia expressed poor sleep quality. However, there was no association between glycemic control level and poor sleep quality.

Keywords

Type II Diabetes, Sleep Quality, Pittsburgh Sleep Quality Index, Glycemic Control

1. Introduction

Diabetes mellitus (DM) is considered one of the highest global health emergencies of the 21st century, according to the International Diabetes Federation (IDF) [1]. It has been estimated that approximately 415 million adults aged 20 - 79 present with diabetes worldwide [2]. In 2015, it has been estimated that around 5 million deaths were induced by diabetes. Furthermore, it is assumed that diabetic patients may grow to reach nearly 642 million in 2040, provided that no extra-preventive measures will be taken [2].

The Kingdom of Saudi Arabia (KSA) has one of the highest world prevalence rates of type II diabetes mellitus [3]. The Arabian Gulf wealth, including KSA has led to better living conditions resulting in an increase in urbanization, major changes in nutrition, decreased physical activity, and further dependency on migrant workers [3]. In KSA, the prevalence of diabetes mellitus (DM) in adults was 25% [4]. Recent research in Saudi Arabia suggested that more than 44% of individuals aged 55 or older had severe uncontrolled diabetes with long-term complications [5].

Diabetes has some serious complications, if improperly controlled including cardiovascular disease, kidney failure, blindness and lower-limb amputations [6]. Risk factors for diabetes mellitus complications can be modifiable or not modifiable. Moreover, complications can be much less in people with well-controlled blood sugar levels [7].

Inadequate sleep is one of the commonest complaints encountered in the general practice [8]. Its prevalence was estimated at 41% among patients attending primary care settings, mainly primary insomnia (12%) and obstructive sleep apnea (9%) [9].

Sleep disturbance has a negative effect on work efficiency and quality of life [8]. Experimental and observational studies have indicated that poor sleep quantity and quality are associated with an increased risk of chronic diseases including insulin resistance [10]. In addition, an association has been observed be-

tween increased risk of pre-diabetes and difficulty in initiating sleep [11].

During sleep, Leptin hormone is secreted, that acts to balance out the need for intake of food intake and energy consumption [12]. During sleep deprivation, leptin is secreted in excessive amounts resulting in increased food intake, especially carbohydrates, which can lead to or aggravate obesity, which in turn predisposes to diabetes mellitus [13]. Additionally, sleep deprivation could increase cortisol levels which inhibits insulin production, which may induce in the long run a pre-diabetes state or even development of diabetes [14].

During sleeping, normal persons maintain a balance between insulin secretion and glucose uptake, which lead to sustained normal blood glucose levels. However, in diabetic patients this balance is disturbed as a result of low blood glucose levels [15].

Sleep disorders have been reported to aggravate diabetes due to decreased glucose metabolism and elevated cortisol levels. In addition, it can increase the risk for the development of diabetes [16].

Reviewing of literature revealed relatively few studies investigating the association between sleep disturbance and type II diabetes as well as the impact of sleep disorders on glycemic control among those patients, with no study carried out in KSA. The following is a briefing of the most relevant studies.

In Singapore (2014) [17], Zhu and research team carried out a cross-sectional study to assess the quality of sleep among 220 patients with type II diabetes (T2DM) and its effect on glycaemic control. The Pittsburgh Sleep Quality Index (PSQI) was utilized to assess the sleep quality with a threshold of $PSQI \geq 8$. The mean \pm SD of PSQI score was 8.30 ± 4.12 . The prevalence of sleep disorder was 47.1%. Patients with glycosylated haemoglobin A1c (HbA1c) $\geq 7\%$ had significantly lower PSQI global and factor scores ($p < 0.01$) compared to controls. Poor glycaemic control was significantly associated with sleep latency, sleep disturbance, and daytime dysfunction.

In Taiwan (2012) [8], Tsai conducted a cross-sectional study aimed to assess the relations of sleep quality with glycaemic control and its influence on type II diabetic patients. The Chinese version of the Pittsburgh Sleep Quality Index (PSQI) questionnaire was utilized, and good sleep quality was determined with PSQI score ≤ 5 . Total PSQI score and sleep efficiency were significantly correlated with the level of HbA1C, after controlling for the effect of gender, age and body mass index. Logistic regression analysis revealed that the adjusted odds ratio (AOR) of sleep efficiency for HbA1C level was 6.83, $p = 0.002$ and the AOR of worse glycaemic control for the poor sleep quality group was 6.94, $p < 0.05$ with regard to the group of good sleep quality.

In Brazil (2008) [18], Cunha *et al.* carried out an observational, cross-sectional to assess the association between sleep disturbance and glycemic control in type II diabetic patients. Poor sleep quality was reported among 52% of the respondents. The PSQI scores showed patients over 10 years from onset of diabetes diagnosis and those with hypertension had the poorest sleep quality. Patients with HbA1c $> 7\%$, even those who had normal body mass index (BMI), the sleep

quality was poorer.

In North Korea [19], Cho and his research team carried out a cross-sectional survey to estimate the prevalence of sleep disturbances and investigate their association with gluco-regulation in 614 type II diabetic patients. The frequency of insomnia among the patients was 48.2% while excessive daytime sleepiness was reported among 8.5% of them. Almost half (49%) were considered poor sleepers. Multivariate logistic regression analysis revealed no significant association between HbA1c and any sleep disturbances (poor sleep, insomnia, and short duration of sleep).

In Spain (2016) [20], Lecube *et al.* carried out a case-control survey to compare type II diabetic patients and non-diabetic subjects regarding polysomnography and daytime sleepiness (using the Epworth Sleepiness Scale (ESS)). Also, they compared cases and controls using PSQI to assess sleep quality. Excessive daytime sleepiness (ESS > 10) was reported among 23.9% of type II diabetic patients and this was significantly higher than that reported in higher in control subjects ($p = 0.003$). Patients with fasting plasma glucose (FPG > 13 mmol/l) were identified as the group with a higher risk associated with an ESS > 10 (OR 3.9, $p = 0.0003$). The presence of type II diabetes, baseline glucose levels and gender independently predicted the ESS score. Also, T2DM patients had higher sleep disturbances than control subjects.

The link of inadequate sleep with diabetes, particularly type II has been studied rarely worldwide, however, up to our knowledge; it was not studied in Saudi Arabia, specifically in Taif. Worldwide, sleep quality was not investigated enough among diabetic patients. Therefore, in this study, we will investigate it. Glycaemic control is essential in the management of, and risk decrease in microvascular complications of diabetes. So, its link to sleep quality should be explored.

To investigate the sleep quality and its determinants and impact on glycemic control of type II diabetic patients attending Diabetic center, Prince Mansour hospital, Taif Saudi Arabia.

To assess sleep quality among type II diabetic patients attending Diabetic center, Prince Mansour hospital, Taif Saudi Arabia. To identify factors associated with poor sleep quality among type II diabetic patients attending Diabetic center, Prince Mansour hospital, Taif Saudi Arabia. To assess the impact of sleep quality on glycemic control among type II diabetic patients attending Diabetic center, Prince Mansour hospital, Taif Saudi Arabia.

2. Methodology

The study was carried out at Taif city, which is located in the West of Saudi Arabia. The estimated population is 688,693 according to 2020 estimated census [21]. In Taif, there are four military hospitals; Al-Hada, Prince Mansour Community, Prince Sultan and Rehabilitation center. This study will be carried out at Prince Mansour Community hospital (PMCH), which was opened in 1951 and has re-

cent extensions and the hospital now has 210 beds. Cross sectional study design was adopted.

All patients diagnosed with type II Diabetes that were seen in Prince Mansour Military Hospital Diabetic Center in Taif throughout the study period (March-July 2021), provided that they have the eligibility criteria for inclusion. Inclusion criteria: diabetic patients aged 18 years or more. type II Both genders, all nationalities. Exclusion criteria: gestational diabetes, type I diabetes, patients with acute diabetic complications, patients with severe cardiac, lung or mental problems

Determining Appropriate Sample Size [22]: 282 type II diabetic patients with 10% were added to the total sample size for the non-respondents. Thus, a total of almost 310 patients were invited to participate in the study.

Through reviewing the statistical records of the diabetic center for three months (January-March 2020).

A self-administered questionnaire was utilized in the present study (Appendix 1). It includes 5 main parts: demographic data of the patients (age, gender, marital status, number of children, residence, type of accommodation, nationality, highest qualification, job status and income). Medical and social history (duration of diabetes, presence of diabetic complications, treatment of diabetes, satisfaction with treatment, having family support, having social problems). The Pittsburgh Sleep Quality Index (PSQI) was utilized to assess the subjective sleep quality and its disturbance over the last month. It is composed of 19 items, with scores of seven components: “subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction.” Each component got a score ranging between zero and three. The sum of scores for these 7 components revealed the PSQI global score, which ranges between zero and 21; the highest PSQI score indicates poorest quality of sleep. The sensitivity and specificity of the PSQI score were 89.6 and 86.5, respectively. A score of PSQI exceeding 5 indicates “poor sleepers” and $PSQI \leq 5$ indicates “good sleepers” [23]. In this study, we used the Arabic validated version [24]. Permission from the University of Pittsburgh was requested to use the questionnaire. Weight and height measurements [25] (weight and height were measured by the researcher and filled in the questionnaire). Body mass index (BMI) assesses the body weight relative to height. The most recent glycated hemoglobin (HbA1c), taken within the last three months, was recorded from the patients’ charts.

The data were collected and verified by hand then coded before computerized data entry. The statistical Package for Social Sciences (SPSS) software version 26.0 was used for data entry and analysis. Descriptive statistics (e.g., number, percentage, mean, range, standard deviation) and analytic statistics using chi-square test were applied in bivariate analysis. Multivariate logistic regression analysis was done to determine predictors of poor quality of sleep among type II diabetic patients, after controlling for confounders. P-values < 0.05 were considered as statistically significant.

The researcher fulfilled all the required official approvals, particularly the approval of the regional Research and Ethics committee and those of the hospital and diabetic centers directors. Before giving questionnaires to patients, informed consent was asked from all the chosen subjects then, all of them had the right not to participate in the study or to withdraw from the study prior to completion. The researcher explained the purpose of the study to all respondents. Confidentiality and privacy were guaranteed for all participants.

3. Results

3.1. Response Rate and Demographic Characteristics of the Participants

The study included 270 type II diabetic patients out of a targeted 282 with a response rate of 95.7% as revealed in **Table 1** presents their demographic characteristics. Most of them aged either between 51 and 60 years (34.8%) or over 60 years (42%). Females represent 63% of them. Vast majority were Saudi nationals (99.6%). 74.5% had married and most of them (72.6%) have more than three kids, lived in urban places (84.4%) and had private houses (76.6%). Majority of the participants (89.6%) had no job and the income of about half of them (50.6%) was less than 5000 SR/month. Regarding the highest qualification, 39% were illiterate while 12.9% were university/above graduated.

3.2. Medical and Social Characteristics of the Participants

Duration of diabetes exceeded 10 years among almost half of the participants (53.4%). History of diabetic complications was mentioned by about half of patients (53.2%). Regarding used medications, 39.1% reported oral hypoglycemic medications whereas 22.3% and 36.4% reported either insulin alone or a combination of oral hypoglycemic medications with insulin, respectively. Majority of patients (77.9%) were very satisfied with diabetic treatment and 85.4% reported family support in treating diabetes. History of having social stressors was mentioned by 12.3% of patients. Prevalence of current smoking was 6.1% as shown in **Table 2**.

3.3. Glycemic Control

As presented in **Figure 1**, majority of the type II diabetic patients 238 had HbA1c \geq 7%, indicating uncontrolled blood glucose levels.

3.4. Sleep Quality

It is evident from **Figure 2** that 162 of the participants described their sleep quality as very good whereas 16 and 9 described it as fairly bad and very bad, respectively.

In **Table 3**, 27.9% of the participants stayed between 16 and 30 minutes in bed to fall asleep each night in the past month whereas 8% of them stayed more than one hour. Moreover, **Table 4** discovered that, almost one-fifth of them (21.4%)

Table 1. Demographic characteristics of type II diabetic patients, Diabetic Center, Prince Mansour Military hospital, Taif, Saudi Arabia ($n = 270$).

<i>Variables</i>	Frequency	Percentage
<i>Age (years) (n = 267)</i>		
<i>18 - 30</i>	11	4.1
<i>31 - 40</i>	12	4.5
<i>41 - 50</i>	39	14.6
<i>51 - 60</i>	93	34.8
<i>>60</i>	112	42.0
<i>Gender</i>		
<i>Male</i>	100	37.0
<i>Female</i>	170	63.0
<i>Nationality</i>		
<i>Saudi</i>	269	99.6
<i>Non-Saudi</i>	1	0.4
<i>Marital status</i>		
<i>Single</i>	16	5.9
<i>Married</i>	201	74.5
<i>Divorced/ widowed</i>	53	19.6
<i>Number of kids</i>		
<i>No</i>	18	6.7
<i>1 - 2</i>	20	7.4
<i>3</i>	36	13.3
<i>>3</i>	196	72.6
<i>Residence</i>		
<i>Rural</i>	42	15.6
<i>Urban</i>	228	84.4
<i>Type of housing</i>		
<i>Private</i>	207	76.6
<i>Governmental</i>	8	3.0
<i>Rented</i>	55	20.4
<i>Having a job</i>		
<i>Yes</i>	28	10.4
<i>No</i>	242	89.6
<i>Income (SR/ month) (n = 261)</i>		
<i><5000</i>	132	50.6

Continued

<i>5001 - 10,000</i>	79	30.3
<i>10,001 - 15,000</i>	30	11.5
<i>>15,000</i>	20	7.6
<i>Highest qualification</i>		
<i>Illiterate</i>	105	39.0
<i>Primary school</i>	63	23.3
<i>Intermediate school</i>	30	11.1
<i>Secondary school</i>	37	13.7
<i>University/above</i>	35	12.9

Table 2. Medical and social characteristics of type II diabetic patients, Diabetic Center, Prince Mansour Military hospital, Taif, Saudi Arabia ($n = 270$).

Variables	Frequency	Percentage
<i>Years of diabetes (n = 268)</i>		
<i><1</i>	14	5.2
<i>1 - 5</i>	40	14.9
<i>6 - 10</i>	71	28.5
<i>>10</i>	143	53.4
<i>History of diabetic complications (n = 267)</i>		
<i>Yes</i>	125	46.8
<i>No</i>	142	53.2
<i>Medications used for diabetes (n = 269)</i>		
<i>Diet</i>	6	2.2
<i>Oral hypoglycemic</i>	105	39.1
<i>Insulin</i>	60	22.3
<i>Oral hypoglycemic and insulin</i>	98	36.4
<i>Satisfaction with diabetes treatment (n = 267)</i>		
<i>Very satisfied</i>	208	77.9
<i>Somewhat satisfies</i>	39	14.6
<i>Neutral</i>	9	3.4
<i>Somewhat dissatisfied</i>	8	3.0
<i>Very dissatisfied</i>	3	1.1
<i>Having family support in treating diabetes (n = 268)</i>		
<i>Yes</i>	229	85.4
<i>No</i>	39	14.6

Continued

<i>Having social stressors (n = 269)</i>			
<i>Yes</i>	33	12.3	
<i>No</i>	236	87.7	
<i>History of smoking (n = 262)</i>			
<i>Current smoker</i>	16	6.1	
<i>Ex-smoker</i>	31	11.8	
<i>Never smoker</i>	215	82.1	

Table 3. Sleep pattern among type II diabetic patients in the past month.

Variables	Frequency	Percentage
<i>Duration in minutes to fall asleep each night (n = 262)</i>		
<i>≤15</i>	127	48.5
<i>16 - 30</i>	73	27.9
<i>31 - 60</i>	41	15.6
<i>>60</i>	21	8.0
<i>Hours of actual sleep at night (n = 268)</i>		
<i><5</i>	32	11.9
<i>5 - 6</i>	42	15.7
<i>6 - 7</i>	110	41.1
<i>>7</i>	84	31.3
<i>Habitual sleep efficiency (n = 268)</i>		
<i><65%</i>	32	11.9
<i>64% - 74%</i>	39	14.6
<i>75% - 84%</i>	116	43.3
<i>≥85%</i>	81	30.2

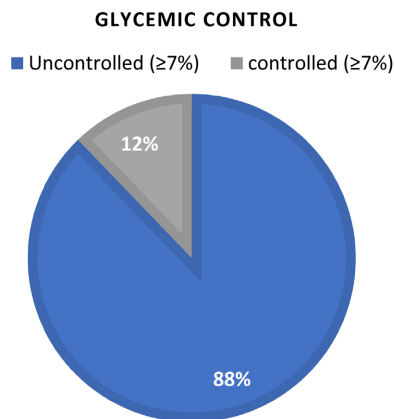


Figure 1. Glycemic control among type II diabetic patients, based on HbA1c level.

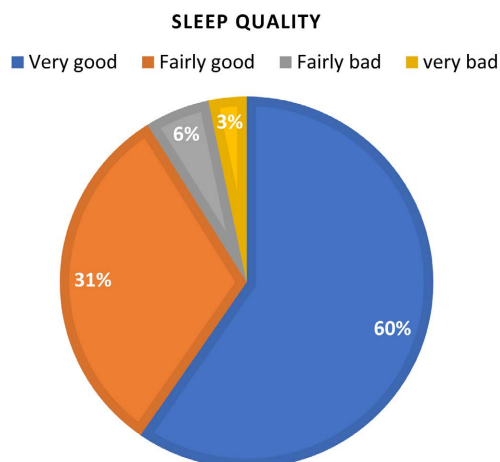


Figure 2. Subjective sleep quality among type II diabetic patients, Diabetic Center, Prince Mansour Military hospital, Taif, Saudi Arabia.

Table 4. Frequency of sleep troubles during the past month among type II diabetic patients.

	Not during the	Less than	Once or	Three times or
	past month	once a week	twice a week	more a week
	N (%)	N (%)	N (%)	N (%)
<i>Cannot get to sleep within 30 minutes (n = 266)</i>	135 (50.8)	32 (12.0)	42 (15.8)	57 (21.4)
<i>Wake up in the middle of the night or early morning (n = 264)</i>	116 (43.9)	32 (12.1)	53 (20.1)	63 (23.9)
<i>Have to get up to use the bathroom (n = 265)</i>	46 (17.4)	36 (13.6)	63 (23.8)	120 (45.3)
<i>Cannot breathe comfortably (n = 265)</i>	214 (80.8)	21 (7.9)	11 (4.2)	19 (7.2)
<i>Cough or snore loudly (n = 263)</i>	184 (70.1)	23 (8.7)	23 (8.7)	33 (12.5)
<i>Feel too cold (n = 269)</i>	190 (70.7)	24 (8.9)	24 (8.9)	31 (11.5)
<i>Feel too hot (n = 269)</i>	169 (62.9)	32 (11.9)	34 (12.6)	34 (12.6)
<i>Have bad dreams (n = 268)</i>	189 (70.5)	39 (14.6)	26 (9.7)	14 (5.2)
<i>Have pain (n = 268)</i>	148 (55.2)	34 (12.7)	37 (13.8)	49 (18.3)
<i>Other reasons (n = 256)</i>	249 (97.2)	4 (1.6)	0 (0.0)	3 (1.2)
<i>Using sleep medications</i>	247 (91.5)	4 (1.5)	6 (2.2)	13 (4.8)
Having troubles staying awake while driving, eating meals or engaging in social activities (n = 269)	213 (79.2)	28 (10.4)	11 (4.1)	17 (6.3)
How much a problem has it been for you to keep up enthusiasm to get things done (n = 265)	185 (69.8)	32 (12.1)	28 (10.6)	20 (7.5)

cannot get to sleep within 30 minutes three times or more a week in the past month.

Table 3 shows that almost one-third of the type II diabetic patients (31.3%) sleep actually more than 7 hours per night each day in the past month while 11.9% of them reported sleeping for less than five hours each night.

Habitual sleep efficiency was less than 65% among 11.9% of the type II diabetic patients while it was 85% or above among another 30.2% of them. For more details look to **Table 3**.

From **Table 4**, it is shown that the commonest reported sleep troubles (three times or more in a week) in the past month, except for sleep latency were getting up to use the bathroom (45.3%), waking up in the middle of the night or early morning (23.9%), and having pain (18.3%).

Only 4.8% of the type II diabetic patents reported using sleep medications three times or more a week to help in sleep in the past month as shown in **Table 4**.

Having troubles staying awake while driving, eating meals, or engaging in social activities in frequencies of three times or more a week were reported by 6.3% of the participants in the last month. Additionally, 7.5% of them reported that three times or more a week, this problem has it been for them to keep up enthusiasm to get things done as exposed in **Table 4**.

3.5. Overall Sleep Quality

Overall, poor sleep quality, based on PSQI was observed among 91 of type II diabetic patients as illustrated in **Figure 3**.

3.6. Factors Associated with Overall Sleep Quality among Type II Diabetic Patients

3.6.1. Demographic Characteristics of Patients

Among studied demographic factors, only marital status and income of type II diabetic patients were significantly associated with overall sleep quality. Poor sleep quality was more observed among divorced/widowed patients compared to married patients (61.5% versus 36.3%) as shown in **Figure 4**, $p = 0.016$. More

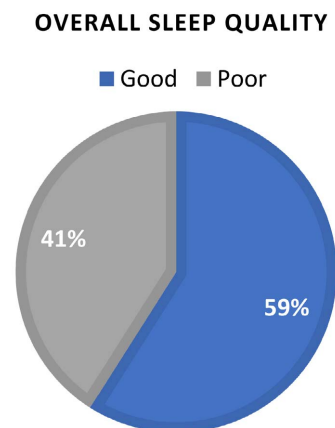
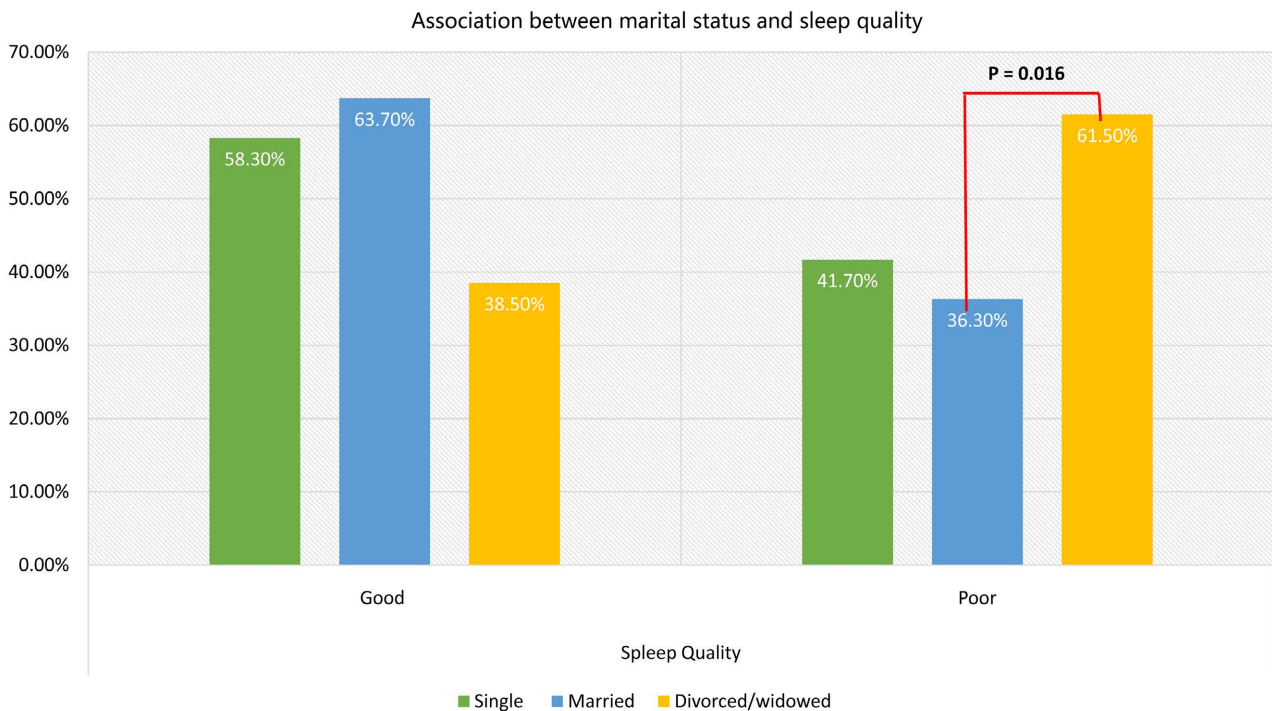
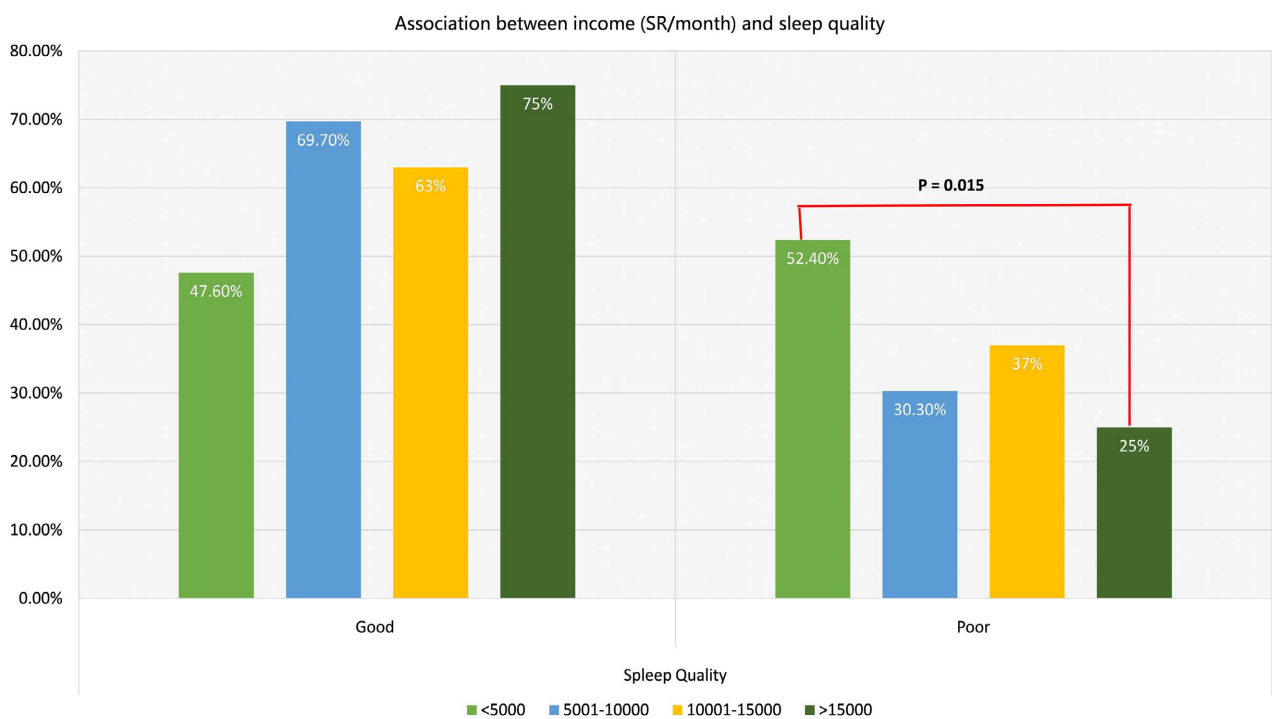


Figure 3. Overall sleep quality among type II diabetic patients (n = 219).



(a)



(b)

Figure 4. The association between marital status, income and the sleep quality.

than half (52.4%) of patients whose income was less than 5000 SR/month compared to only 25% of those whose income exceeded 15,000 SR/month expressed poor sleep quality, $p = 0.015$. **Table 5** contains more details.

Table 5. Association between demographic characteristics of type II diabetic patients and overall sleep quality.

Variables	Overall sleep quality		p-value
	Good N = 129	Poor N = 90	
<i>Age (years)</i>			
<i>18 - 30 (n = 8)</i>	5 (62.5)	3 (37.5)	
<i>31 - 40 (n = 11)</i>	7 (63.6)	4 (36.4)	
<i>41 - 50 (n = 27)</i>	18 (66.7)	9 (33.3)	
<i>51 - 60 (n = 84)</i>	44 (52.4)	40 (47.6)	
<i>>60 (n = 86)</i>	54 (62.8)	32 (37.2)	0.587*
<i>Gender</i>			
<i>Male (n = 83)</i>	53 (63.9)	30 (36.1)	
<i>Female (n = 136)</i>	76 (55.9)	60 (44.1)	0.245*
<i>Nationality</i>			
<i>Saudi (n = 218)</i>	129 (59.2)	89 (40.8)	
<i>Non-Saudi (n = 1)</i>	0 (0.0)	1 (100)	0.411**
<i>Marital status</i>			
<i>Single (n = 12)</i>	7 (58.3)	5 (41.7)	
<i>Married (n = 168)</i>	107 (63.7)	61 (36.3)	
<i>Divorced/widowed (n = 39)</i>	15 (38.5)	24 (61.5)	0.016*
<i>Number of kids</i>			
<i>No (n = 13)</i>	7 (53.8)	6 (46.2)	
<i>1 - 2 (n = 16)</i>	12 (75.0)	4 (25.0)	
<i>3 (n = 33)</i>	21 (63.6)	12 (36.4)	
<i>>3 (n = 157)</i>	89 (56.7)	68 (43.3)	0.480*
<i>Residence</i>			
<i>Rural (n = 35)</i>	17 (48.6)	18 (51.4)	
<i>Urban (n = 184)</i>	112 (60.9)	72 (39.1)	0.175*
<i>Type of housing</i>			
<i>Private (n = 169)</i>	100 (59.2)	69 (40.8)	
<i>Governmental (n = 6)</i>	3 (50.0)	3 (50.0)	
<i>Rented (n = 44)</i>	26 (59.1)	18 (40.9)	0.904*

Continued

<i>Having a job</i>			
<i>Yes (n = 21)</i>	14 (66.7)	7 (33.3)	
<i>No (n = 198)</i>	115 (58.1)	83 (41.9)	0.447*
<i>Income (SR/month)</i>			
<i><5000 (n = 103)</i>	49 (47.6)	54 (52.4)	
<i>5001 - 10,000 (n = 66)</i>	46 (69.7)	20 (30.3)	
<i>10,001 - 15,000 (n = 27)</i>	17 (63.0)	10 (37.0)	
<i>>15,000 (n = 16)</i>	12 (75.0)	4 (25.0)	0.015*
<i>Highest qualification</i>			
<i>Illiterate (n = 87)</i>	46 (52.9)	41 (47.1)	
<i>Primary school (n = 49)</i>	28 (57.1)	21 (42.9)	
<i>Intermediate school (n = 23)</i>	16 (59.6)	7 (30.4)	
<i>Secondary school (n = 34)</i>	24 (70.6)	10 (29.4)	
<i>University/above (n = 26)</i>	15 (57.7)	11 (42.3)	0.357*

*Chi-square test; **Fischer Exact test.

3.6.2. Medical and Social Factors

Poor sleep quality was highest reported among patients with longest duration of diabetes (>10 years) (46.5%) and lowest reported among those with lowest duration of diabetes (<1 year) (18.2%), $p = 0.033$ look to **Figure 5**. Only 35.4% of patients who were very satisfied with diabetes treatment compared to all of those who were somewhat dissatisfied with treatment had poor sleep quality, $p = 0.004$ as demonstrated in **Figure 6**. Most of patients who reported having social stressors (72.7%) compared to 37.6% of those who did not report social stressors had poor sleep quality, $p = 0.001$. Other studied factors, including glycemic control were not significantly associated with sleep quality as shown in **Table 6**.

3.7. Predictors of Poor Sleep Quality

Results of multivariate logistic regression analysis revealed that compared to patients whose income was lower than 5000 SR/month, those with income of 50,001 - 1000 and >15,000 SR/month were at lower significant risk for having poor sleep (Adjusted odds ratio "AOR" = 0.44, 95% confidence interval "CI" = 0.22 - 0.86, $p = 0.016$ and AOR = 0.21, 95% CI = 0.06 - 0.77, $p = 0.019$; respectively). As opposed to diabetic patients with a duration of less than one year of DM, those with a duration exceeding 10 years were at almost 6 folds higher risk for poor sleep quality (AOR = 6.39, 95% CI = 1.12 - 36.43, $p = 0.037$). Patients with history of social stressors were at higher significant risk for poor sleep quality compared to those without such history (AOR = 4.99, 95% CI = 1.71 - 14.67, $p = 0.003$). Patient's satisfaction with treatment and marital status were not statistically associated with poor sleep quality after controlling for confounders as shown in **Table 7**.

Table 6. Association between medical and social characteristics of type II diabetic patients and overall sleep quality.

Variables	Overall sleep quality		p-value*
	Good N = 129	Poor N = 90	
<i>Years of diabetes</i>			
<1 (n = 11)	9 (81.8)	2 (18.2)	
1 - 5 (n = 33)	22 (66.7)	11 (33.3)	
6 - 10 (n = 60)	37 (61.7)	23 (38.3)	
>10 (n = 114)	61 (53.5)	53 (46.5)	0.033
<i>History of diabetic complications</i>			
Yes (n = 98)	52 (53.1)	46 (46.9)	
No (n = 118)	77 (65.3)	41 (34.7)	0.069
<i>Medications used for diabetes</i>			
Diet (n = 6)	5 (83.3)	1 (16.7)	
Oral hypoglycemic (n = 88)	50 (56.8)	38 (43.2)	
Insulin (n = 40)	23 (57.5)	17 (42.5)	
Oral hypoglycemic and insulin (n = 84)	50 (59.5)	34 (40.5)	0.642
<i>Satisfaction with diabetes treatment</i>			
Very satisfied (n = 175)	113 (64.6)	62 (35.4)	
Somewhat satisfies (n = 29)	11 (37.9)	18 (62.1)	
Neutral (n = 7)	2 (28.6)	5 (71.4)	
Somewhat dissatisfied (n = 3)	0 (0.0)	3 (100)	
Very dissatisfied (n = 3)	1 (33.3)	2 (66.7)	0.004
<i>Having family support in treating diabetes</i>			
Yes (n = 189)	114 (60.3)	75 (39.7)	
No (n = 29)	14 (48.3)	15 (51.7)	0.220
<i>Having social stressors</i>			
Yes (n = 22)	6 (27.3)	16 (72.7)	
No (n = 197)	123 (62.4)	74 (37.6)	0.001
<i>History of smoking</i>			
Current smoker (n = 12)	4 (33.3)	8 (66.7)	
Ex-smoker (n = 27)	19 (70.4)	8 (29.6)	
Never smoker (n = 174)	102 (58.6)	72 (41.4)	0.095*
<i>Glycemic control</i>			
Controlled (HbA1c < 7%)	16 (53.3)	14 (46.7)	
Uncontrolled (HbA1c ≥ 7%)	113 (59.8)	76 (40.2)	0.504*

*Chi-square test.

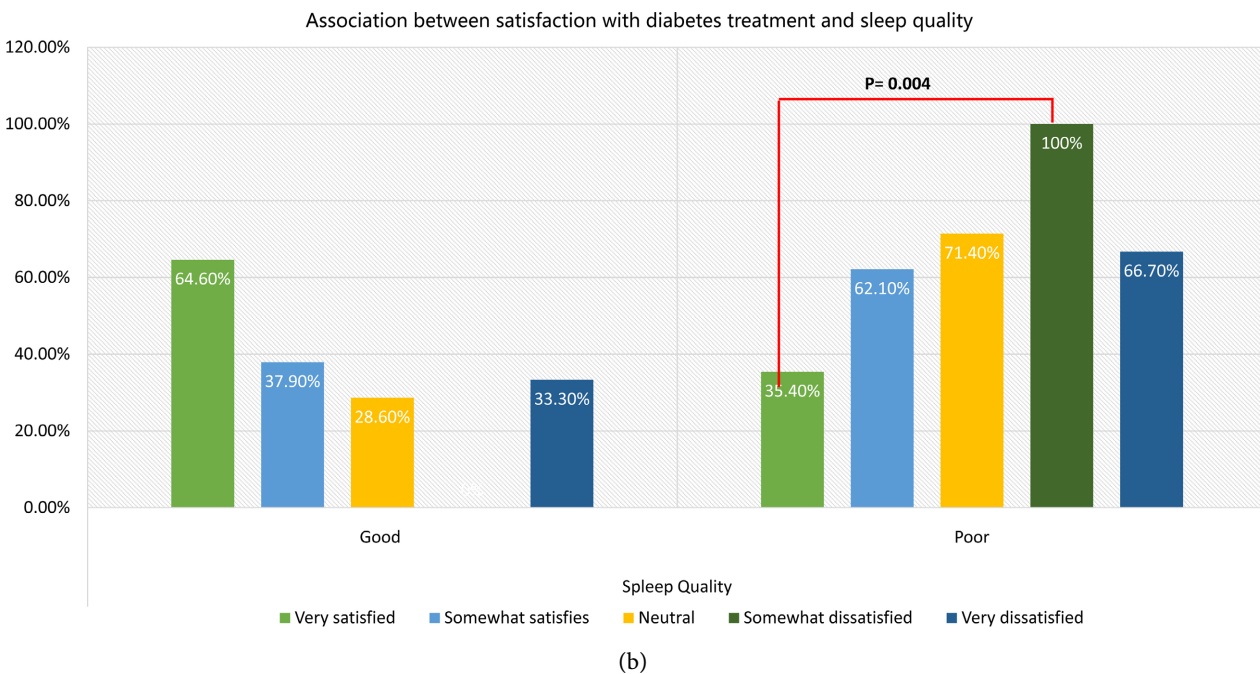
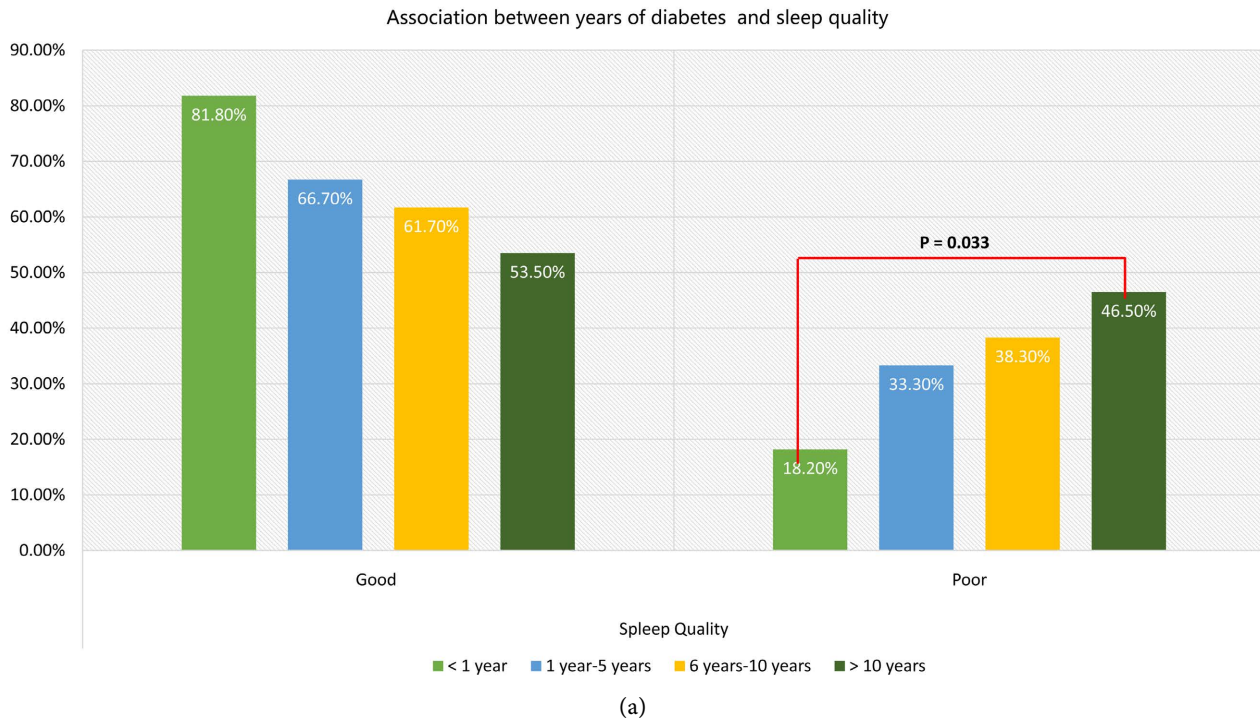


Figure 5. The association between years of diabetes, satisfaction with diabetes treatment and the sleep quality.

4. Discussion

Several studies have documented poor sleep quality as a risk factor for diabetes [25] [26] [27], through a neuro-endocrine metabolic pathway [28]. Also, patients with sleep disorder experienced decrease in the insulin sensitivity, which result in elevated blood glucose and aggravates the course of diabetes [17]. Additionally, poor sleep quality can assist the hypothalamic-pituitary-adrenocortical

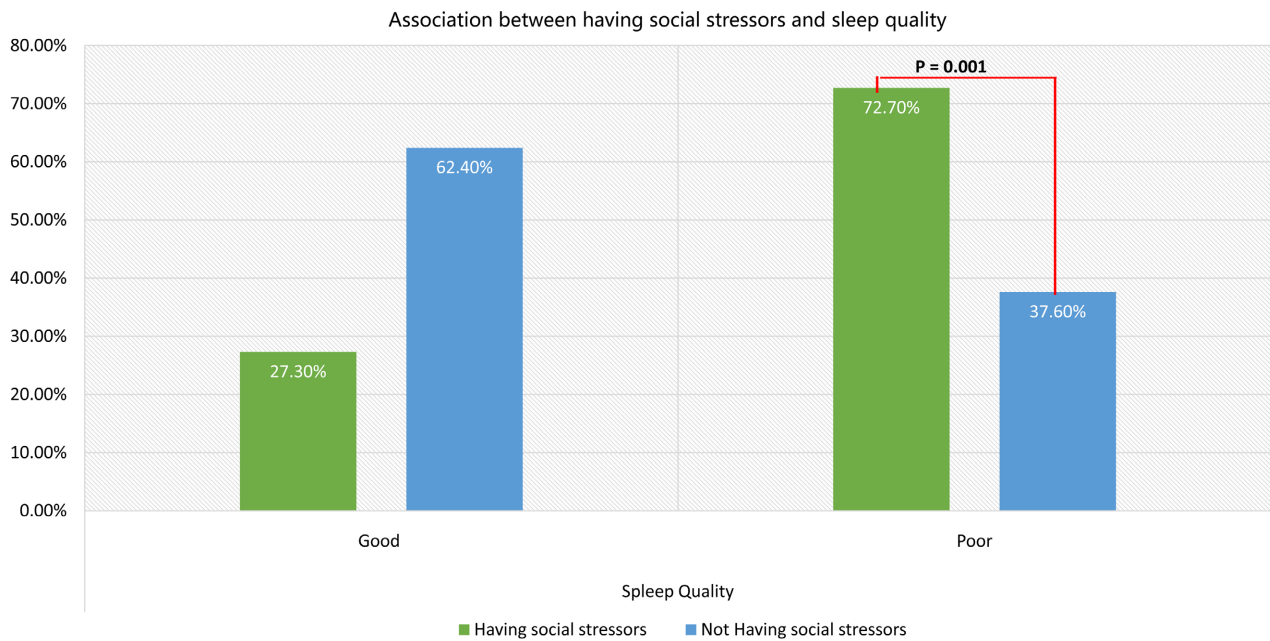


Figure 6. The association between having social stressors and the sleep quality.

Table 7. Predictors of poor sleep quality among type II diabetic patients: Multivariate logistic regression analysis.

	B	SE	AOR	95% CI	p-value
<i>Income (SR/ month)</i>					
<5000 ^a			1.0	-	
5001 - 10,000	-0.832	0.346	0.44	0.22 - 0.86	0.016
10,001 - 15,000	-0.678	0.469	0.51	0.20 - 1.27	0.148
>15,000	-1.553	0.661	0.21	0.06 - 0.77	0.019
<i>Years of diabetes</i>					
<1 ^a			1.0	-	
1 - 5	1.052	0.945	2.86	0.45 - 18.25	0.266
6 - 10	1.601	0.912	4.95	0.83 - 29.62	0.079
>10	1.855	0.888	6.39	1.12 - 36.43	0.037
<i>Having social stressors</i>					
No ^a			1.0	-	
Yes	1.610	0.549	4.99	1.71 - 14.67	0.003

B: Slope; SE: Standard error; AOR: Adjusted odds ratio. CI: Confidence interval. ^a: Reference category. Terms of satisfaction with treatment and marital status were not statistically significant and removed from the final logistic regression model.

system to produce more glucocorticoid, which result in increase in the glucose production with decrease consumption, which affect the glycaemic control [29] [30].

On the other hand, polyuria and nocturia that are characterizing diabetes mellitus are considered leading reasons for sleep disturbance; affecting mainly sleep onset and maintenance [31].

In the current study, poor sleep quality, based on PSQI as a subjective tool using a cut-off of 5 was observed among 41.1% of type II diabetic patients. In another similar study carried out in Singapore, however using a cut-off level of 8 for PSQI, the rate of poor sleep quality was 47.1% [17]. In Brazil [18], poor sleep quality was reported among 52% of the type II diabetic patients. In North Korea [19], the frequency of insomnia among the type II diabetic patients was 48.2%.

Other studies reported higher rates of poor sleep quality ranging between 69% and 73.9%, using a cut-off value of 5 for PSQI [32] [33] [34]. In Spain (2016) [20], Lecube *et al.* reported that T2DM patients had higher sleep disturbances than control subjects. Comparison between studies, including the present one, is somewhat difficult due to differences in the patients' characteristics, particularly age which is a known factor that might impact sleep quality.

In the present study, glycemic control, based on HbA1c level of <7% was reported among only 12.2% of type II diabetic patients. In other studies, also only 24.3%, 39.1% and 15.5% of the type II diabetic patients expressed glycaemic control [8] [17] [35]. This indicates ineffective management of diabetes, even in specialized center, which necessitates further in-depth investigation for the underlying causes.

In the current study, glycemic control manifested by HbA1c < 7% was not associated with sleep quality. Zhu, *et al.* (2014) found that type II diabetic patients with glycosylated haemoglobin A1c (HbA1c) \geq 7% had significantly lower PSQI score ($p < 0.01$) compared to controls [17]. On the other hand, Tsai, *et al.* (2012) concluded that the total PSQI score, and sleep efficiency were significantly correlated with the level of HbA1C, after controlling for the effect of gender, age and body mass index [8]. In Brazil [18], patients with HbA1c > 7%, even who had normal body mass index (BMI), the sleep quality was poorer. In North Korea [19], multivariate logistic regression analysis revealed no significant association between HbA1c and any sleep disturbances (poor sleep, insomnia, and short duration of sleep). Furthermore, some authors suggested that enhancing sleep quality and treating sleep disorder could be used as among methods applied to achieve glycaemic control [36] [37].

This study revealed that after controlling for confounders in multivariate logistic regression analysis, patients with lower income, those with a duration of diabetes exceeding 10 years and those with a history of social stressors were at higher risk for poor sleep quality compared to their counterparts. In a study carried out in Brazil by Cunha *et al.* [18], patients with over 10 years from onset of diabetes diagnosis and those with hypertension had the poorest sleep quality.

Among important limitations of the study is its inclusion in one health care setting in Taif, which could impact the generalizability of findings. However, this is a highly specialized diabetic center and includes patients from all Taif areas military and civilians. The cross-sectional design adopted in the present study is

another limitation as it proves only association between variables and not causality. Depending on subjective method to diagnose sleep quality instead of objective one is considered also a limitation. However, PSQI is a valid tool used in several international studies to assess sleep quality.

5. Conclusion

A considerable proportion of type II diabetic patients attending the diabetic center, Prince Manasour Military hospital in Taif, Kingdom of Saudi Arabia expressed poor sleep quality, particularly those with low income, longer duration of diabetes and those with a history of social stressors. Additionally, Majority of patients had poor glycaemic control. However, there was no association between glycaemic control level and poor sleep quality.

Recommendations

Based on the present's study findings, the following are recommended: physicians should pay more attention to screening for poor sleep quality among type II diabetic patients, and consequently provide adequate measures to improve the situation earlier. Further assessment of the sleep quality among type II diabetic patients utilizing objective methods such as polysomnography besides the subjective tool to have more confident results. Providing further intervention to type II diabetic patients with poor sleep quality. More strict interventions should be implemented for patients with poor glycaemic control. Furthermore, a comprehensive study including type II diabetic patients from other healthcare organizations in Taif is needed to have a clearer image of the situation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix 1

The questionnaire

This questionnaire to find out the self-management behaviours to control Type II diabetes.

The information in this questionnaire will remain confidential. Require the mobilization of the questionnaire (2) minutes. We thank for your cooperation and your answer.

AGREE	DISAGREE
A) Personal data	
1) Medical ID (MRN):	
2) Age:	
20 - 30	31 - 40 41 - 50 51 - 60 >60
3) Gender:	
Male	Female
4) Nationality:	
Saudi:	Non-Saudi:
5) Marital status:	
Married	not married widowed divorce
6) Do you have children?	
No	1 2 3 >3
7) Housing	
Village	City
8) Type of accommodation:	
Owner	Rent Government
9) Do you work or have a job?	
YES (specify).....	NO
10) Monthly Income	
0 - 5000	6000 - 10,000 11,000 - 15,000
16,000 - 20,000	>20,000
11) The highest academic degree:	
No education	Primary Intermediate Secondary
University	Post graduate
B) Medical history:	
12) Since when suffering from diabetes?	
Less than a year	1 - 5 years 6 - 10 years >10 years
Do you suffer from complications of diabetes?	
Yes (specify).....	No
13) What kind of treatment you use	
Diet	Insulin Pills Insulin and pills
14) Are you satisfied of your diabetic treatment?	
Satisfied	Somewhat satisfied I agree not to agree
Somewhat	Dissatisfied Dissatisfied

C) Social factors:

15) Do you find the support of the family in taking the treatment

Yes No

Do you suffer from social pressures?

Yes No

Are you smoker?

Yes No

D) This particular part of your doctor:

16) Sugar cumulative hemoglobin (HBA1C level)

Weight: KG Hight: m

The Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

During the past month,

- 1) When have you usually gone to bed? _____
- 2) How long (in minutes) has it taken you to fall asleep each night? _____
- 3) When have you usually gotten up in the morning? _____
- 4) How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed) _____
- 5) During the past month, how often have you had trouble sleeping because you

	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times a week (3)
a) Cannot get to sleep within 30 minutes				
b) Wake up in the middle of the night or early morning				
c) Have to get up to use the bathroom				
d) Cannot breathe comfortably				
e) Cough or snore loudly				
f) Feel too cold				
g) Feel too hot				
h) Have bad dreams				
i) Have pain				
j) Other reason(s), please describe, including how often you have trouble sleeping because of this reason(s):				

6) During the past month, how often have you take medicine (prescribed or “over the counter”) to help you sleep?

7) During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

8) During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

Very good (0)

Fairly good (1)

Fairly bad (2)

Very bad (3)

9) During the past month, how would you rate your sleep quality overall?

Component 1 #9 Score C1_____

Component 2 #2 Score (<15 min = 0; 16 - 30 min = 1; 31 - 60 min = 2, > 60 min = 3) + #5a Score

(if sum is equal 0 = 0; 1 - 2 = 1; 3 - 4 = 2; 5 - 6 = 3) C2_____

Component 3 #4 Score (>7 = 0; 6 - 7 = 1; 5 - 6 = 2; <5 = 3) C3_____

Component 4 (total # of hours asleep)/(total # of hours in bed) × 100

>85% = 0, 75% - 84% = 1, 65% - 74% = 2, <65% = 3 C4_____

Component 5 Sum of Scores #5b to #5j (0 = 0; 1 - 9 = 1; 10 - 18 = 2; 19 - 27 = 3) C5_____

Component 6 #6 Score C6_____

Component 7 #7 Score + #8 Score (0 = 0; 1 - 2 = 1; 3 - 4 = 2; 5 - 6 = 3)

C7_____

Add the seven component scores together _____

Global PSQI Score_____