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Original Research Article.

Sleep Quality Assessment in Saudi Patients with Type 2 Diabetes from National Guard Primary Healthcare Centers: A Cross-Sectional Study

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ABSTRACT

Background: The prevalence of Type 2 diabetes mellitus (T2DM) is increasing in our society and is associated with high morbidity and mortality. Patients with diabetes have higher rates of sleep problems and poor sleep quality.

Objectives: To assess the subjective of sleep quality in Saudi patients with type 2 diabetes (T2DM), and to explore patient demographics and morbidities associated with poor sleep quality.

Methods: We conducted a cross-sectional study among Saudi patients with T2DM in primary care settings. Patients aged 27 years or older were included in the study. We gathered information about patients' characteristics and medical history and recorded glycated hemoglobin (HbA1c%) from patients` files. A trained nurse collected physical examination from the participants. Quality of sleep was evaluated through the Pittsburgh Sleep Quality Index (PSQI) tool. A Global Sleep Quality score >5 discriminates between good and poor sleepers.

Results: 280 patients were included in the study. Approximately 58% were male and 42% were female. The mean PSQI score was 5.3, indicating poor sleep quality in this population. The mean PSQI score was higher in females compared to males. No association was found between sleep quality and age, duration of diabetes, or HbA1c% level.

Conclusion: There is a high prevalence of poor sleep quality in patients with T2DM. A strong association was found between gender and quality of sleep. Also, patients with psychiatric problems had poorer sleep quality compared to those without psychiatric problem. Physicians should address sleep problems in patients with type 2 diabetes and help manage them.

Keywords: Sleep Quality, Type 2 Diabetes Mellitus, HbA1c, Pittsburgh Sleep Quality Index.

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INTRODUCTION

Type II Diabetes Mellitus (T2DM) is a critical and rapidly growing public health problem which is creating many challenges to humanity. Diabetes is associated with reduced life expectancy; the significant morbidity associated with diabetes arises from microvascular and macrovascular complications, including ischemic heart disease, stroke, and peripheral vascular disease (macrovascular), and diminished quality of life.[1] Unfortunately, in 2015 the number of patients with T2DM reached 415 million worldwide according to the International Diabetes Federation.[2] At 15.2%, the Middle East and North Africa Region (MENA) has the highest prevalence of T2DM compared to other areas.[2] Since the 20th century, the rise in the prevalence of T2DM in the Kingdom of Saudi Arabia started to draw attention after rapid industrialization took place in the country.[3] Research conducted since the late 1980s has revealed a rising trend among Saudi adults. According to the International Diabetes Federation (2013), the prevalence of T2DM in Saudi Arabia was 23.9%,[4] slightly higher than what was reported in 2011 (23.1%).[5]

Although many advances have been made in treatment, many patients with T2DM continue to die from macrovascular complications. Diabetes kills more than 10% of all adults in the MENA region.[4] Intervention strategies including improving dietary habits, increasing physical activity, and decreasing weight are the basis of diabetes prevention and management.[6] However, more efforts are needed to better understand other determinants of the disease and to develop new strategies. Understanding the link between diabetes and sleep may represent an important part of these efforts. Poor sleep quality and sleep disorders, mainly insomnia, are common problems in primary care among patients with T2DM.[7,8] Sleep problems were common (>90% for any problem; 10%-40% for individual issues), and people with diabetes were more likely than those without diabetes to report sleep problems such as sleep apnea and inadequate sleep.[9] In a primary care setting, one in three middle-aged Saudi males is at risk for obstructive sleep apnea [OSA].[10] In the U. S., Spiegel and colleagues found that sleep deprivation may influence carbohydrate metabolism.[11] Other U.S. studies found that short-term sleep restriction was associated with decreased insulin sensitivity and increased Insulin resistance.[12,13] These results showed that short sleep duration or poor sleep quality might be associated with glucose metabolism.[12,13] Obstructive sleep apnea is a common sleep disorder with increasing incidence and believed to be a risk factor for cardiovascular diseases.[14] While there is an association between OSA and glucose metabolism or insulin resistance, OSA was shown to be a novel risk factor for diabetes and metabolic syndrome.[15-17] Several studies have looked at the association between sleep and markers of diabetes or glucose control. Sleep durations of six hours or less or nine hours or more were found to be associated with increased prevalence of diabetes and impaired glucose tolerance.[18,19] A study in Italy showed that poorly managed T2DM might be associated with sleep disturbances, even in the absence of complications or obesity.[20] Another study in China revealed that poor sleep quality was considerably correlated with inadequate glycemic control in subjects with type 2 diabetes.[21] A Saudi Arabian study examined the relationship between sleep and the risk of obesity, which is a risk factor for diabetes. The study showed a significant association between high prevalence of short sleep duration among Saudi adolescents and increased risk of overweight and obesity.[22-24] The purpose of this study was to assess the prevalence of poor sleep quality in patients with T2DM by using the Pittsburg Sleep Quality Index (PSQI) tool. Another objective was to explore the association between sleep quality and diabetes control, hypertension, dyslipidemia, gender, age, weight, respiratory problems, and thyroid problems.

METHODS

This is a cross-sectional study conducted among Saudi patients with T2DM, at the Ministry of National Guard Primary Health Care and diabetes care centers in Riyadh. The total population served by the target centers was estimated to be 250,000 participants. Based on a 31.6% age-adjusted diabetes prevalence rate in the Saudi population,[5] the study population is estimated to be 79,000 participants. BaHammam et al. estimated the prevalence of obstructive sleep apnea to be 33.3% among Saudi men and 39% among Saudi women.[10,25] Using a conservative 30% prevalence, +/-5% margin of error, 95% confidence interval, the sample size was calculated using a Piface calculator. The calculated sample size was 316 subjects adjusted to 320 to account for non-response. Eligible subjects were recruited via a convenience sampling method. The data were collected over a period of 35 days at a rate of 10 subjects per day. Participants were recruited every day until the calculated sample size was achieved.

We included participants aged 27 years or older with a previous diagnosis of T2DM documented in their medical charts. We invited patients to our study who came for a follow-up visit in PHC centers [Khashm Alaan and Iskan] or the Iskan diabetes center, from September 2013 to January 2014. We excluded from the study patients with type 1 diabetes or gestational diabetes.

Measurements

A trained nurse measured the height and the weight for each patient: the height measured in centimeters and the weight measured in kilograms. Subjects were asked to stand on the weight scale bare-footed wearing light clothing. Body mass index (kg/m2) was calculated. The normal BMI range was 18.5-24.9 kg/m2. Participants with a BMI of 25.0-29.9 kg/m2 were classified as overweight, those ≥30.0 kg/m^2 were classified as obese, and those below 18 kg/m2 were considered underweight. The most recent glycated hemoglobin (HbA1c), taken within the last three months, were recorded from the patients` charts.

The Questionnaire

We designed a questionnaire in Arabic consisting of three parts: socio-demographics, medical history, and questions from the Pittsburgh Sleep Quality Index (PSQI).The socio-demographic data section gathered information about age, gender, marital status, and occupation. For medical history, the interviewer asked patients whether they had been diagnosed by a medical professional with one or more of the following conditions: hypertension, dyslipidemia, thyroid problems, respiratory problems and psychiatric problems. Patients were also asked about smoking status and frequency of regular physical exercise (thrice/week, twice/week, once/week or rarely).

The Pittsburgh Sleep Quality Index (PSQI) is a self-completed questionnaire that assesses subjective sleep quality and disturbances over the preceding month.[26] The scale included 19 individual items, which generate seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. Each component is scored from zero to three. The sum of scores for these seven components yields the PSQI global score, from zero to 21; poorest quality is indicated by the highest PSQI score. The sensitivity and specificity of the diagnostic value of a global PSQI score were 89.6 and 86.5, respectively. A PSQI>5 indicates "poor sleepers" and PSQI≤5 for "good sleepers." Suleiman and colleagues translated the English tool to Arabic, then tested and validated it; the details of this process were published in the Western Journal of Nursing Research.[27] In this study, we used this validated version after obtaining permission from the University of Pittsburgh.

Ethical Considerations

The study was approved by King Abdullah International Medical Research Center (KAIMRC). Each patient was provided with brief information about the study and was assured of strict confidentiality and received informed consent. Patients were aware of their right to withdraw from the study at any time.

Statistical Analysis

Statistical analysis was conducted using SPSS version 20 (SPSS Inc., Chicago, IL, USA). Quantitative variables were expressed as mean ± standard deviation, and qualitative variables were expressed as percentage values. Cronbach's alpha, a measure of internal consistency, was used to evaluate the correlation of the nine questions on having trouble sleeping. Those include "cannot get to sleep within 30 minutes," "wake up in the middle of the night or early morning," "have to get up to use the bathroom," "cannot breathe comfortably," "cough or snore loudly," "feel too cold," "feel too hot," "have bad dreams," and "have pain." The student t-test was used to ascertain the significance of differences between mean values of continuous variables and a Chi-square test was performed to explore associations in the proportions of categorical variables.

All tests were two-tailed, and we set the level of significance at P values of ≤ 0.05. Binary logistic regression analysis was used to analyze the effects of age, gender, obesity, HbA1c, hypertension, psychiatric problems, and the duration of diabetes on sleep quality. The stepwise method was used, with entry and removal probabilities of 0.05 and 0.1, respectively. The odds ratios (OR) and 95% confidence intervals (CI) were determined for all variables.

Table 1: Participants' Characteristics:

Variable		N	Percent (%)
Sex	**Male**	163	58.2
	Female	117	41.8
Age (years)	**27-40**	22	7.9
	41-54	130	46.4
	55-75	128	45.7
Mean age ± SD		54.0±9.8	
Mean height (cm) ± SD		162.1±9.0	
Mean weight (kg) ± SD		84.7±14.9	
Body mass index (kg/m²)	**18.5-24.9**	19	6.8
	25.0-29.9	81	28.9
	>30.0	178	63.6
Mean BMI ± SD		32.3±5.8	
Mean HbA1c% ± SD		8.7±2.0	
Mean duration of diabetes, y ± SD		9.6±7.3	
Mean PSQI score ± SD		5.3±3.1	
Mean sleep duration, hr ± SD		7.2±2.1	
Insulin use		94	6.0
Marital status	**Married**	252	90
	Unmarried	28	10
Education	**No Education**	120	42.9
	Elementary	74	26.4
	Intermediate high school	78	27.9
	Higher education	8	2.9
Occupation	**Student**	1	0.4
	Employed	47	16.8
	Retired/unemployed	128	45.7
	Housewife	104	37.2
Smoking status	**Current smoker**	21	7.5
	Former smoker	47	16.8
	Never smoked	212	75.7
Exercise	**Rarely**	196	70.0
	≥once/wk	84	30.0
Prevalence of co-morbidities	**Obesity**	178	63.6
	Psychiatric disorders	32	11.4
	Hypertension	132	47.1
	Dyslipidemia	231	82.5
	Respiratory disorders	72	25.7
	Thyroid disorders	23	8.2

Data are given as mean ± Standard Deviation (SD) or percentage.

BMI: body mass index, HbA1c: glycosylated hemoglobin, DM: diabetes mellitus,

PSQI: Pittsburgh Sleep Quality Index.

RESULTS

Analysis was conducted using descriptive statistics of 280 patients with type 2 diabetes who completed the study (Response rate= 87.5%).There were more males (58%) than females (42%) in the study sample. The mean age of participants was 54 years, the average BMI was 32.3 kg/m² and the mean of HbA1c% was 8.7. The majority of subjects in our sample were married (90%), only 16.8% were employed, and the majority had secondary education or less (54.3%). Only 7.5% were smokers, and 70% of the patients had no regular weekly exercise. The Cronbach's alpha value for the nine questions on the trouble sleeping scale showed a high score of reliability (α= 0.73).

Table 1 also shows the mean duration of diabetes (9.6 years), and that approximately one third (33.6%) of participants were on insulin. The mean Pittsburgh sleep quality index (PSQI) Global Score was 5.3, indicating poor overall sleep quality with a mean sleep duration per night of 6.8 hours. Dyslipidemia was the most common comorbidity reported in our study (82.5%). Hypertension was reported in nearly half of the patients, and respiratory problems were found in almost 25%, mainly bronchial asthma. Approximately 7% had hypothyroidismand32 patients (11.4%) were shown to have at least one psychiatric problem. More than half of the subjects in the study population were obese.

Table 2 compares the mean and percentage of some baseline characteristics, which may have an effect on sleep, by gender. Male patients were older (55.4, *P*= 0.003) and females had a higher mean BMI (34.7, *P*< 0.0001) andHbA1c (9, *P*= 0.023). In our sample, thyroid disorders were significantly more common among females than males (17.1% vs. 1.8%, *P*< 0.0001) and psychiatric disorders were more common among females than males, though not significant (15.4% vs. 8.6%, *P*= 0.078). No differences were found between the genders in hypertension and respiratory problems. The proportion of patients using insulin and the mean duration of diabetes was similar in both genders. PSQI score was significantly higher among females (6.0) compared to males (4.7), which means poor overall sleep quality among females (*P*<0.01).

Table 3 shows that among the seven components of the Pittsburgh Sleep Quality Index (PSQI), the minimum score among all components was zero and the maximum was three. The mean score of sleep latency was 1.19, which was the highest among the other components, and the mean sleep latency duration was 31 minutes. The lowest mean score was in sleep medication use (0.12), indicating that the use of sleep medication was rare in the sample. The minimum global PSQI score was zero and the maximum was 17. The prevalence of poor sleep quality (n= 151, 53.9%) (i.e. global PSQI score >5) was higher than g good sleep quality (n= 129, 46.1%).

Table 4 shows the association between patients' characteristics and sleep quality. A substantial evidence of association was found between gender and overall sleep quality (x^2=11.4, *P*=0.01), with the majority of females reporting poor sleep quality (65.8%) compared to males (45.4%). A higher mean BMI was seen among subjects with poor sleep quality (32.7 kg/m2) compared to good sleepers (31.8 kg/m2), although this difference was not statistically significant (t=1.29, *P*=0.19). This table showed that the less educated participants were more likely to experience poor sleep (x^2=8.8, P=0.012). The mean sleep duration per night was lower among those with poor sleep quality (6.7hours) compared to 7.8 among good sleepers (t =4.1, P<0.01). Smoking was also significantly associated with sleep quality: 76.2% of smokers reported poor sleep quality (x^2=4.5, P=0.033). Around 53% of participants who exercised regularly every week had good sleep quality, although this was not statistically significant. Approximately 78% of those with psychiatric disorders had poor sleep quality (χ^2=8.5 *P*=0.004), compared to 21.9% who had good sleep quality. More than half of obese patients (58.4%) fell into the poor sleep quality category (χ^2=3.9,*P*=0.046).

Table 2: Baseline characteristics by gender (n= 280)

	Male (n= 163)	Female (n= 117)	P-value
Age, y **	55.4±10.3	52.0±8.5	0.003
BMI kg/m²**	30.6±5.2	34.7±5.7	<0.001
HbA1c % **	8.4±1.9	9.1±2.0	0.023
Duration of T2DM, y	9.8±7.8	9.3±6.4	0.611
Hypertension	47.9%	46.2%	0.809
Thyroid disorders **	1.8%	17.1%	<0.001
Psychiatric disorders	8.6%	15.4%	0.078
Respiratory disorders	27.0%	24.0%	0.816
Insulin use	32.5%	35.0%	0.190
PSQI Score, mean ± SD**	4.7±2.6	6.0±3.6	0.001

Data are given as mean ± Standard Deviation (SD) or percentage.

BMI: body mass index, HbA1c: glycosylated hemoglobin, DM: diabetes mellitus, PSQI: Pittsburgh Sleep Quality Index,

χ^2: Chi square test, t: student-t test.

Table 3: PSQI components scores:

SSQI components	N	Cronbach's alpha	Mean±SD	Min	Max
PSQI Score of the sample	280	0.73	5.3±3.1	0	17

PSQI: Pittsburgh Sleep Quality Index.

Table 4: Association between patients' characteristics and sleep quality:

Patients characteristics		Good sleep quality (PSQI ≤ 5) n= 129 (46.1%)	Poor sleep quality (PSQI > 5) n= 151 (53.9%)
Age, y		54.8±9.6	53.3±9.8
BMI, kg/m²		31.9±5.6	32.7±5.9
HbA1c%		8.8±2.0	8.6±2.0
Diabetes control	**>7**	49 (43.0%)	65 (57.0%)
	≤7	80 (48.2%)	86 (51.8%)
Gender**	**Female**	40 (34.2%)	77 (65.8%)
	Male	89 (54.6%)	74 (45.4%)
Social status	**Married**	118 (46.8%)	134 (53.2%)
	Unmarried	11 (39.3%)	134 (60.7%)
Education**	**No education**	47 (39.2%)	73 (60.8%)
	School education	75 (49.3%)	77 (50.7%)
	Higher education	7 (87.5%)	1 (12.5%)
Sleep duration per night (hours)**		7.8±1.2	6.8±2.2
DM duration, y		9.5±6.5	9.7±7.8
Insulin use		41 (43.6%)	53 (56.4%)
Obesity**		75 (41.7%)	105 (58.3%)
Psychiatric disorders**		7 (21.9%)	25 (78.1%)
Hypertension		65 (49.2%)	67 (50.8%)
Dyslipidemia		103 (44.6%)	128 (55.4%)
Respiratory disorders		33 (46.5%)	38 (53.5%)
Thyroid disorders		7 (30.4%)	16 (69.6%)
Smoking status**	**Smoker**	5 (23.8%)	16 (76.2%)
	Non-smoker	124 (47.9%)	135 (52.1%)
Weekly exercise	**Regular**	45 (53.6%)	39 (46.4%)
	Rarely	84 (42.9%)	112 (57.1%)

Data are given as mean ± Standard Deviation (SD) or percentage.

BMI: body mass index, HbA1c: glycosylated hemoglobin, DM: diabetes mellitus, PSQI: Pittsburgh Sleep Quality Index, χ^2: Chi square test, t: student-t test. ** P value < 0.05

Table 5: Results of multivariate logistic regression analysis of the association between patient's characteristics and disturbed subjective sleep:

	B	S.E.	OR	95% C.I. for EXP(B)		*P*-value
				Lower	Upper	
Obesity (No vs. Yes)	-0.11	0.33	0.90	0.47	1.71	0.736
Sex (Female vs. Male)	0.91	0.33	2.49	1.32	4.69	0.005
DM duration interval (< 5 yrs vs. > 10 yrs)	0.18	0.45	1.20	0.50	2.88	0.681
DM duration interval (> 5 to 10 yrs vs. > 10 yrs)	-0.44	0.38	0.65	0.31	1.35	0.245
Hypertension (Yes Vs. No)	-0.48	0.32	0.62	0.33	1.15	0.128
Dyslipidemia (No Vs. Yes)	-0.47	0.40	0.63	0.29	1.38	0.245
Psychiatric Problems (Yes Vs. No)	1.35	0.55	3.86	1.32	11.30	0.014
AGE	0.01	0.02	1.01	0.98	1.05	0.426
HbA1c Level	-0.06	0.08	0.95	0.80	1.11	0.502

B, regression coefficient. SE, standard error. OR, odds ratio. CI, confidence interval. HbA1c, glycosylated hemoglobin HbA1c.

Table 5 shows the results of the multiple logistic regression analysis used to analyze the association between patients' characteristics and disturbed subjective sleep. Females had a significantly poorer sleep quality compared with males ($OR_{female\ vs.\ male}$ = 2.49, 95% CI 1.32-4.69, *P*= 0.005).

Patients with psychiatric problems had significantly poorer sleep quality ($OR_{yes\ vs.\ no}$= 3.86, 95% CI 1.32-11.30, *P*= 0.014) compared to those without psychiatric problems. Poor sleep quality was clinically associated with higher diabetes duration, hypertension, and dyslipidemia.

DISCUSSION

Diabetes mellitus is an internationally challenging medical problem with significant morbidity and mortality. Across different populations, several studies explored various aspects of sleep disturbances in patients with T2DM. Previous studies indicated that insufficient sleep might reduce glucose intolerance and increase the risk of developing T2DM.[11,18] Other studies found a relationship between poor sleep quality and T2DM.[20,21] The relationship between sleep disorders and T2DM is less understood and less studied in the Saudi population.

In our study, the prevalence of sleep disturbances was common and present in more than half of the patients (53.9%). This prevalence is smaller than a study conducted among Indians (69%) and in another study among Arabs living in Qatar (60.1%).[22,23] An Italian study showed that poor control ofT2DMmight be associated with sleep disturbances, even in the absence of complications or obesity.[20] Possible causes for this difference could be due to age, medical services, poverty, lifestyle, or race.[20] A meta-analysis showed that obtaining fewer than six hours of sleep each night, compared to seven hours, might increase type 2 diabetes risk by approximately 30%.[19]

Female patients with T2DMwere more likely to have sleep disturbances compared to males (65.8% vs 45.4%); this relationship between gender and sleep quality was also found in other studies.[22,23,28] The mechanisms by which gender may influence the prevalence of poor sleep quality are still unknown, but our research indicated it could be related to poor disease management or the higher prevalence of obesity among females. These two factors are associated with poor sleep independently of gender.[29,30] Another factor affecting sleep quality among females could be the higher prevalence of thyroid disorders compared to males. A case study showed that sleep disturbances often were associated with thyroid problems.[31] Our findings indicated that obese patients were likely to have poor sleep quality; however, the effect of obesity was not indicated as an independent risk factor in the logistic regression model. Similarly, obesity was associated with sleep disorders[29] and in obstructive sleep apnea (OSA).[32] Moreover, a study by Rajendran et al. 2012. [22] found an association between a higher BMI and increasing PSQI score, which indicated increased likelihood of sleep disturbance.

Interestingly, though our study indicated that patients with a longer duration of T2DM had poor sleep quality, the association was not significant, and no association was seen between sleep quality and HbA1c. Few studies found similar results of no association between sleep disturbances and controlling T2DM.[22,28] However, other studies have found better sleep duration, quality, and efficiency were significantly associated with lower HbA1c.[20,30]

Sleep deprivation was higher among patients with psychiatric problems, and is one of the criteria for a depression diagnosis.[33] Al-Ghamdi 2004[34] stated in his study that the prevalence of depression in Saudis with T2DMis 34%; the prevalence of depression in our sample was 4.6%.In our study, however, we did not have the tools needed to screen for depression, so we relied only on physician observations. Psychiatric problems were an independent risk factor for poor sleep. Two other studies were found to have similar results on sleep latency as in our study, in which it was the most affected PSQI component in the sample.[22,28]

The association between smoking and poor sleep quality has been seen in previous studies, especially in increasing sleep latency and decreasing sleep duration.[35,36] Most smokers in our sample, as expected, had poor subjective sleep quality. Education level was related to sleep quality in our study: patients with T2DMwith at least primary school education had better sleep quality than those with no education. However, lack of education could be a proxy indicator for other lifestyle factors that affect sleep quality. No other studies have reported similar finding.

Our study has several limitations. First, we lacked a control group of participants without diabetes to facilitate a direct comparison. Second, we did not have polysomnographic measures of sleep, so it was not possible to detect sleep disorders such as obstructive sleep apnea. Also, the possibility of confounding effects was difficult to exclude by unmeasured variables, such as a poor diet or sedentary lifestyle. Furthermore, the PSQI tool is subjective and depends on the patient's memory of the preceding month. Finally, a cross-sectional study design lacks the methodological strength necessary to establish causal relationships.

CONCLUSION AND RECOMMENDATIONS

Poor sleep is a common problem in Saudi patients with T2DM, as shown by higher global PSQI scores. Females had a significantly poorer sleep quality compared with males. Also, patients with psychiatric problems had poorer sleep quality compared to those without psychiatric problems. More research is needed to explore the types of sleep disorders in patients with T2DM. We recommend that physicians screen T2DM patients for sleep problems.

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