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ORIGINAL RESEARCH

The Prevalence of Sleep Disorders in People with Type 2 Diabetes and Obesity in Saudi Arabia: A Cross-Sectional Study

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Purpose: Difficulty falling or staying asleep are considered sleep disorders, and these are common among people with type 2 diabetes mellitus (T2DM) and obesity. The presence of sleep disorders may cause poor glycemic control among this population. We therefore designed this study to assess sleep disorders among patients with T2DM and obesity.

Patients and Methods: This cross-sectional study examined the prevalence of sleep disorders in 148 patients with T2DM and obesity at a hospital in Taif, Saudi Arabia using a validated questionnaire.

Results: Among those patients who have been involved in this study, we found a moderate level of sleep disorders and disturbances. The average sleep disorder assessment score for the patients with T2DM and obesity was 2.8 ± 1.4. Additionally, the average score for the sleep pattern assessment was 2.7 ± 1.3 and 2.9 ± 1.5 for symptoms of lack of sleep. Our study also revealed that those patients also had suboptimal weight and glycemic control.

Conclusion: These findings demonstrate that patients with T2DM and obesity are at a higher risk of developing sleep disorders. Therefore, these patients need to be screened for sleep disorders to avoid further diabetes-related complications and to have an early lifestyle intervention.

Keywords: sleep disorders, type 2 diabetes mellitus, obesity, prevalence, Saudi Arabia

Introduction

A good night's sleep is essential for good health. The general public and the medical community are becoming more aware of the importance of sleep hygiene for both physical and mental health, and there is considerable interest in the prevention and treatment of sleep disorders and related issues.[1–3] Sleep disorders are defined as difficulties falling or staying asleep as well as feeling restless while sleeping. Among the many significant consequences, sleep disturbances can have fatal outcomes. Numerous studies have revealed that 50–70% of people with diabetes experience sleep disturbances.[4,5] Obesity and sleep disorders are two of the most common health problems among people with type 2 diabetes mellitus (T2DM). People with T2DM and obesity have a higher risk of insomnia, poor sleep quality, excessive daytime sleepiness, and higher use of sleeping medications compared to the general population.[6,7]

Sleep problems in people with T2DM can lead to poor glycemic control, diabetic neuropathy, and nocturnal hypoglycemia.[8,9] Diabetes and sleep problems, which are related, can exacerbate glycemic control. Furthermore, diabetes can cause sleep abnormalities. The likelihood of problems arises with either shorter or longer lengths of sleep.[9] Obesity, on the other hand, is related to diabetes as a parallel condition, and the term "diabesity" reflects their close relationship. Both metabolic disorders are characterized by insulin action defects.[10] Previous studies have reported that patients with

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obesity face a 14% higher likelihood of developing diabetes every two years.[11] More than a third of the world's population is overweight or obese, which places them at risk of developing T2DM.[12]

Despite the availability of various management approaches, the prevalence of obesity and T2DM has increased significantly over the past several decades, and some studies have projected that this trend will continue in the years to come. Both of these have detrimental impacts on one's health and finances. For example, T2DM can lead to microvascular complications and cardiovascular problems, among other concerns. Furthermore, obesity can increase the risk of T2DM, cardiovascular disease, and cancer-related mortality.[13]

The length of sleep is a major factor in T2DM and high body mass index (BMI). Over time, there has been a decline in the average length of sleep and an increase in the incidence of short sleepers. This has resulted in a rise in the percentage of fat in the body, a reduction in the insulin response, insulin resistance, and glucose intolerance. A study has shown that, long sleepers also had a higher BMI and a higher relative risk of T2DM as short sleepers. Additionally, variations in body weight may result in variations in the length of sleep.[14,15] According to a study conducted in Saudi Arabia, sleep problems are common among persons with T2DM. Furthermore, compared to people with other chronic conditions, patients with endocrine abnormalities had lower-quality sleep. The results also showed that the quality of sleep is impacted by chronic hyperglycemia.[16]

Researchers continue to investigate sleep disorders in patients with obesity and T2DM. However, to the best of our knowledge, very few studies on this topic have been conducted in Saudi Arabia, with a scarcity of recent data on sleep disorder prevalence specifically in Saudi patients with T2DM and obesity. Therefore, the current study was designed with the goal of evaluating sleep disorders among patients with obesity and T2DM in Taif, Saudi Arabia. In addition, we hypothesized that this population would have a high prevalence of sleep disorders that require screening and intervention.

Materials and Methods

Study Design and Participants

A descriptive analytical approach was used in this study to present and describe the study variables and to rule out sleep disorders in patients with obesity and T2DM at King Abdul Aziz Specialized Hospital, Taif. The study population consisted of all patients with obesity and T2DM at King Abdul Aziz Specialized Hospital who were identified in the follow-up appointment system during the last three months of 2022. All obese T2DM patients, from both genders, following at the participating center during the study period were included. Obesity was defined as a BMI of more than or equal 30 Kg/m2. However, non-obese patients and those with communication disorders were excluded from the study to prevent potential biases that could arise from miscommunication or misunderstanding of the questionnaire items. Moreover, communication disorders that could impede this process, including severe hearing impairments, profound speech difficulties, and significant cognitive impairments affecting comprehension were also excluded. Additionally, any patient with missing data was excluded from the study. This study was approved by the Directorate of Health Affairs, Taif, Saudi Arabia, which oversees research in the Taif region including King Abdulaziz Specialist Hospital. The Research Ethics Committee (REC) approved the study to be done by Dr. Ibrahim Asiri (the principal investigator) whom was a clinical fellow trained there between 2021 and 2022 (HAP-02-T-067). The ethical guidelines and regulations of the Declaration of Helsinki were used to provide informed consent of all participance.

Sample Size and Sampling Technique

According to the hospital's data, the total number of patients with T2DM and obesity during the study period was 250. Using Epi Info version 7.0, the minimum required sample size was 130 patients.

Data Collection Tool and Process

The participants who met the inclusion criteria were invited via WhatsApp messages to complete an online-based questionnaire, which was designed using Google Forms. The questionnaire was accessible from January 2023 for three months. On average, it took the participants four minutes to complete the questionnaire. To avoid duplicate responses, the participants were required to submit their responses using the provided link only once.

Questionnaire Development

The questionnaire was developed based on authors' clinical and research experience, and a valid questionnaire from a previous study, which measured the occurrence of sleep disorders using multiple questions.[17] The questionnaire was divided into four parts. The first part included the patient's demographic data, while the second part assessed sleep pattern using a 16-item Likert-type scale assessing the frequency of 16 characteristic signs such as "I sleep 8 hours per day, on average" or "I feel that I always lack sleep". Furthermore, part three explored the perceived impact of poor sleep on mood using a 5-item Likert-type scale. Meanwhile, part four used 13 questions to explore the practices related to diabetes self-management, including dietary choices, exercise routines, medication adherence, and monitoring of blood glucose levels.

To measure the dimensions of the study variables, the questionnaire contained a five-point Likert scale in parts two and three. The optional responses were (1) always, (2) most of the time, (3) occasionally, (4) a little, and (5) never. The averages of the Likert scale responses were then calculated and classified into three categories: low, moderate, and high. The formula used to calculate the size of each category was (maximum value − minimum value)/number of categorize) = (5 − 1/3) = 1.33. As a result, the length of each category was 1.33, with the first category (low level) ranging from 1 to 2.33, the second category (moderate level) ranging from 2.34 to 3.67, and the third category (high level) ranging from 3.68 to 5.

The internal consistency of the questionnaire was first tested in a pilot study. In the pilot study, 20 responses were collected and analyzed. The Cronbach's alpha of the questionnaire was 72.6%. Each section of the questionnaire was also given a value. The value for the sleep pattern assessment was 68.1%, that for the symptoms of sleep deprivation was 89%, and that for weight and glycemic control was 66.1%. No changes were therefore required to the questionnaire, and the data collection process began.

Diagnosis and Definitions

The diagnosis of T2DM was made either by one reading (ie if the patient is manifesting symptoms of hyperglycemia and has an RBG > 200 mg/dl) or two abnormal readings of different/same methods (RBG > 200 mg/dl, FBG > 126 mg/dl, OGTT > 200 mg/dl, or HbA1c > 6.4%).[18] Additionally, obese patients were defined as those who have a BMI of greater than or equal 30 kg/m^2, according to the World Health Organization (WHO).[19]

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 26 (Armonk, NY: IBM Corp, 2019) was used for the data analysis. Descriptive statistics were carried out to measure frequencies and percentages, on categorical variables, and means and standard deviations (SD) on continuous variables. Cronbach's alpha coefficient was calculated to analyze the internal consistence of the different questionnaire scales, notably Parts 2, 3, and 4. The three constructs—sleep patterns, perceived impact of poor sleep, and practices in diabetes self-management—were analyzed using the total scores, which were calculated by summing the respective item scores. The correlations between these scores were analyzed using Pearson's correlation coefficient. The associations of these scores with categorical variables were analyzed using independent *t*-test or One-way ANOVA test, as applicable. Linear regression was used to analyze the factors associated with sleep pattern and perceived impact of poor sleep, the dependent factors; the independent variables include socio-demographic and clinical data and practice in diabetes self-management. A p-value < 0.05 was considered statistically significant.

Results

Study Sample Characteristics

In total, 148 participants completed the questionnaire and were included in the study. Female participation was higher than male participation, and a large proportion of the participants (39.2%) were between the ages of 51 and 60. The duration of diabetes in most of the patients ranges from 5 to 15 years (Table 1).

Table 1 Characteristics of the Study Sample

Characteristics		**N (%)**
Gender	Male	68 (45.9)
	Female	80 (54.1)
	Total	**148 (100.0)**
Age	Less than 30 years	2 (1.4)
	30–40 years	9 (6.1)
	41–50 years	20 (13.5)
	51–60 years	58 (39.2)
	61–70 years	43 (29.1)
	More than 70 years	16 (10.8)
	Total	**148 (100.0)**
Height	Less than 160 cm	69 (46.6)
	161–170 cm	59 (39.9)
	171–180 cm	18 (12.2)
	More than 180 cm	2 (1.4)
	Total	**148 (100.0)**
Weight	Less than 70 kg	44 (29.7)
	75–80 kg	43 (29.1)
	85–95 kg	25 (16.9)
	96–105 kg	23 (15.5)
	106–115 kg	7 (4.7)
	116–125 kg	3 (2.0)
	126–135 kg	2 (1.4)
	More than 135 kg	1 (0.7)
	Total	**148 (100.0)**
Duration of type 2 diabetes	Less than 5 years	19 (12.8)
	5–10 years	35 (23.6)
	11–15 years	30 (20.3)
	16–20 years	30 (20.3)
	21–25 years	21 (14.2)
	More than 25 years	13 (8.8)
	Total	**148 (100.0)**

(*Continued*)

Table 1 (Continued).

Characteristics		N (%)
Glycated hemoglobin level	Less than 6%	7 (4.7)
	6–7%	35 (23.6)
	8–9%	71 (48.0)
	More than 9%	35 (23.6)
	Total	**148 (100.0)**

Sleep Disorders

The average sleep pattern assessment score was 2.73 ± 1.27, and the average score for the symptoms of sleep deprivation was 2.957 ± 1.48 (Table 2). As a result, the overall average for sleep disorders among the patients with T2DM was 2.84 ± 1.38, which was moderate on the derived scale. To determine whether the averages were significantly high, a one-sample *t*-test was used, as shown in Table 3. The average scores for the sleep pattern assessment and the symptoms of sleep deprivation were found to be significantly higher with p-values less than 0.001 and a t value of −17.193 and −5.343, respectively.

Weight and Glycemic Control

Means and standard deviations were used to identify weight and glycemic control among the patients with T2DM and obesity, and the results are shown in Table 4. The overall average for the control of weight and glucose was 2.945 ± 1.29, which was classified as moderate on the derived scale. As shown in Table 4, the means of weight and glycemic control ranged from 1.189 to 4.250 and had a low-to-high degree of appreciation. The results showed that statement 31 "I drink plenty of water or other unsweetened liquids" had the highest level of appreciation, with a mean of 4.250 and a standard deviation of 1.042. A low level of appreciation was shown for statement 32, which stated, "I keep track of my calories", and it had a mean of 1.189 and a standard deviation of 0.663.

The Effect of Sleep Disorders on Weight and Glycemic Control

To determine the effect of sleep disorders on weight and glycemic control, linear regression was used, as shown in Table 5. Regarding the sleep pattern assessment, it was found that the regression coefficient between the independent and dependent variables was 0.052, while the value of the coefficient of determination (R2) was 0.003, which indicates that

Table 2 Mean and Standard Deviation of Sleep Disorders

No.	Sleep Disorder	Mean ± SD
1	Sleep pattern assessment	2.733 ± 1.273
2	Symptoms of lack of sleep	2.957 ± 1.484
Total		**2.845 ± 1.379**

Table 3 One Sample *t*-test of the Sleep Disorders

No.	Sleep Disorder	Mean	SD	t	Mean Difference	p-value
1	Sleep pattern assessment	2.733	1.273	−17.193	147	<0.001
2	Symptoms of lack of sleep	2.957	1.484	−5.343	147	<0.001

Table 4 Means and Standard Deviations of Weight and Glycemic Control

No.	Statement	Mean ± SD	Rate
1	I eat several small meals.	2.635 ± 1.289	Moderate
2	I eat healthy food.	3.162 ± 1.240	Moderate
3	I count the carbohydrates in my daily meals.	1.264 ± 0.703	Low
4	I ensure each meal is well balanced.	2.946 ± 1.399	Moderate
5	I make sure my meals and medications are consistent.	3.899 ± 1.379	High
6	I avoid consuming sugar-sweetened drinks.	2.730 ± 1.537	Moderate
7	I practice sports.	2.824 ± 1.379	Moderate
8	I keep specific schedules for practicing sport.	2.669 ± 1.445	Moderate
9	I check my blood glucose level frequently.	3.372 ± 1.495	Moderate
10	I drink plenty of water or other unsweetened liquids.	4.250 ± 1.042	High
11	I keep track of my calories.	1.189 ± 0.663	Low
12	I check my blood glucose level regularly.	3.514 ± 1.567	Moderate
13	I take my insulin doses at the precise times recommended by my doctor.	3.838 ± 1.629	High
Control of weight and glucose		**2.945 ± 1.29**	**Moderate**

Table 5 Linear Regression of the Effect of Sleep Pattern Assessment and Symptoms of Lack of Sleep Scores on Quality Control of Weight and Sugar

Model	Sleep Disorder	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	Sleep pattern assessment	0.052	0.003	−0.004	0.58946
2	Symptoms of lack of sleep	0.167	0.028	0.021	0.58196

0.03% of changes in dependent variables caused by independent variables. On the other hand, the regression coefficient between the independent and dependent variables of the symptoms of lack of sleep was 0.167, with 0.28% of changes in dependent variables caused by independent variables. Therefore, One-way ANOVA was used to further analyze the independent variables, as seen in Table 6. It was found that there is no significant difference regarding the effect of the independent variables of sleep pattern assessment on weight and glycemic control (p-value = 0.53). In contrast, it was

Table 6 One-Way ANOVA of the Effect of Sleep Pattern Assessment and Symptoms of Lack of Sleep on Quality Control of Weight and Sugar

Model		Sum of Squares	Diff.	Mean Square	F	p-value
1	Regression	0.137	1	0.137	0.396	0.530
	Residual	50.729	146	0.347		
	Total	50.867	147			
2	Regression	1.420	1	1.420	4.193	0.042
	Residual	49.447	146	0.339		
	Total	50.867	147			

found that there is a significant difference regarding the effect of the independent variables of symptoms of lack of sleep on weight and glycemic control (p-value = 0.042).

Discussion

Many studies have found a link between insufficient sleep, T2DM, and obesity.[20–23] Furthermore, decreased physical activity, and high levels of fast food consumption and screen time use have been linked to obesity and a high incidence of T2DM.[24] As a result, we designed the current study to assess sleep disorders among patients with T2DM and obesity who visited King Abdul Aziz Specialized Hospital in Taif, Saudi Arabia, during the last three months of 2022.

The patients with T2DM and obesity included in our study were found to have a moderate risk of sleep disorders. Similar results have been reported in a previous study, which found that over 86% of patients with T2DM and obesity had undiagnosed obstructive sleep apnea (OSA).[25] Another study showed that patients with T2DM should be screened for daytime sleepiness and experienced apneic events.[20] Other studies have suggested that patients with diabetes and obesity should be screened for sleep problems, insufficient sleep time, and OSA. Obesity and diabetes-related OSA may result in long-term cardiovascular and metabolic complications.[26–29] Additionally, it was found that 24.4% of T2DM patients and 64.52% of obese patients had sleeping symptoms, globally.[30] In comparison to the studies that has been applied in Saudi Arabia, a national study revealed that poor sleep quality was experienced by 170 participants (55.4%) of T2DM patients and 71 participants (64%) of obese patients.[31]

Under normal conditions of the environment, the pineal gland is the primary organ responsible for the nighttime synthesis and secretion of melatonin, which is a biological factor that plays a role in sleep deprivation. The suprachiasmatic nuclei produce the endogenous secretory rhythm, which is synchronized with the light/dark cycle.[32] A study found that melatonin levels increased after sleep deprivation and that it has a transient therapeutic benefit for those with endogenous depression.[33] Furthermore, other factors, including food consumption, food type, smoking, unemployment, leading a sedentary lifestyle, and many others, may have a positive or negative effects on the sleep quality of patients with T2DM and obesity.

Lifestyle changes are an effective way to control obesity and glycemic levels. Obesity and glycemic control can be improved by reducing caloric intake and being involved in structured exercise training programs.[26,34,35] Daily calorie and carbohydrate counting can thus help prevent overeating. However, in our study, very few of the participants tracked their daily carbohydrate and calorie intake. A one-year case–control study that included a dietary intervention and physical activity showed improvements in weight, the apnea hypopnea index, and glycemic levels compared to those who did not receive any interventions.[36] Obesity and diabetes can cause OSA, which can lead to metabolic and cardiovascular disease.[37–39] Patients with obesity and diabetes should therefore be screened for sleep disorders to improve their health outcomes.[29]

Our study had limitations that need to be acknowledged, namely, that it included a small sample size from a single center, which carries the potential for sampling bias, and relied on self-reported data. This approach may lead to inaccurate reporting of thoughts, emotions, or behaviors due to social desirability bias, as well as misunderstandings of the questions, resulting in unreliable responses. Accordingly, the study findings cannot be generalized. As a result, a multi-center study with a large sample size is required to generalize the findings. Another limitation was that the reasons the participant did not count calories and carbohydrate intake were not explored, and these could be investigated in future studies among the Saudi population. Moreover, this study did not measure stress and depression, two factors that could affect the accuracy of our findings. Thus, future studies should incorporate these variables to attain more precise results. Additionally, future longitudinal studies are recommended to assess the impact of T2DM and obesity on sleep quality over time using an objective assessment tool (eg, polysomnography). Also, these studies should focus in exploring the impact of interventions targeting improved sleep quality on metabolic control and weight management.

Conclusion

This study has focus in evaluating the sleep quality in Saudi patients with T2DM and obesity. Based on our findings, we found a moderate level of sleep disorders in Saudi patients with T2DM and obesity using a validated questionnaire. This highlights the need for routine screening and lifestyle interventions to improve sleep health in this high-risk population.

Addressing sleep disorders may also improve weight and glycemic control. However, the patients with T2DM and obesity did not keep calorie diaries, nor did they track the carbohydrates in their daily meals. We therefore recommend that patients with T2DM and obesity be assessed for sleep apnea, reduce their stress and tension levels, go to sleep at the same time every day, and maintain their blood glucose levels within the normal range. Nevertheless, future longitudinal studies are needed to assess the impact of these two diseases on sleep quality over time using an objective assessment tool.

Abbreviations

T2DM, type 2 diabetes mellitus; OSA, obstructive sleep apnea.

Disclosure

The authors report no conflicts of interest in this work.

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