Original Article

Sleep quality and glycemic control in adults with type 2 diabetes mellitus

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Abstract

Aim: Type 2 diabetes mellitus (T2DM) is a common disease that imposes a substantial burden on the healthcare system and patients. Lifestyle modification such as sleep hygiene plays a crucial role in glycemic control. Sleep disorders impact many aspects of health. In this study, we aimed to investigate the correlation between sleep quality and glycemic control in T2DM. **Method:** This cross-sectional study was performed on 163 T2DM patients, attending Shahid Beheshti Hospital in Hamadan, Iran from March 2020 to 2021. Besides recording the demographic data and HbA1c level of participants, they were asked the Pittsburgh Sleep Quality Index questionnaire for evaluating sleep quality. We employed SPSS ver. 21 for data analysis and considered 0.05 as a significant level. **Results:** Among all participants, 62 (38%) were female and 30.7% were illiterate. The mean age was 56.67 ± 12.90 years, and HbA1c was 9.03 ± 1.92 mg/dL. Among sleep metrics, mean waking time was 8.74 ± 1.74 hours, and average sleep time was 12.90 ± 4.90 hours. Overall, 58.2% of the participants had poor glycemic control and 44.8% were suffering from poor sleep quality. We found that patients with poor glycemic control exhibited significantly higher levels of sleep disturbances compared to those with good glycemic control ($P < 0.001$). **Conclusion:** Sleep quality is associated with glycemic control in patients with T2DM. Sleep disorders are common among diabetic patients. Thus, healthcare providers need to consider sleep quality improvement in their holistic approach to diabetes management.

Keywords: Blood glucose control, type 2 diabetes mellitus, sleep

Introduction

Type 2 diabetes mellitus (T2DM) is a serious public health issue that imposes a significant economic burden on the healthcare system, patients, and their families.[1,2] In 2021, approximately 537 million individuals aged 20–79 years had diabetes, and this number is estimated to increase to approximately 643 million by 2030 and 783 million by 2045.[3]

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A study has indicated that three out of four adults diagnosed with diabetes reside in low- and middle-income countries.[4] The Middle East and North Africa Region (MENA), which includes the Islamic Republic of Iran, shows the highest incidence of diabetes cases compared to other regions globally, and Iran ranks third in regard to diabetes incidence within the region.[5] In 2020, approximately 9.4% of adults in Iran were estimated to have diabetes.[6] Despite substantial investments, diabetes remains a prevalent and steadily rising condition in both Iran and worldwide.[1] The microvascular and macrovascular complications of diabetes are the major cause of morbidity and mortality associated with the disease.

In addition, research findings have shown that approximately 80% of the economic burden associated with DM is attributed

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to the management and treatment of these complications.[7,8] Some studies have indicated that maintaining optimal glycemic control (HbA1c ≤ 7%) can lead to a decrease in the incidence of long-term diabetes complications and the overall burden of the disease.[7,9,10]

Several factors have been identified as being associated with poor glycemic control. These factors include sociodemographic characteristics of the patients, duration of diabetes, adherence to lifestyle modifications and medication, and self-monitoring of glucose levels.[11] The prevalence of sleep disturbances and deprivation has been growing in recent years.[12] In addition, it is found that there is a bidirectional relationship between sleep disorders and diabetes: while diabetes and its complications lead to sleep disorders, disturbance in both sleep quality and quantity can lead to poorer diabetes control and a higher complication rate.[13]

Although the pathophysiology of this relationship is not fully understood, there are some possible explanations. Sleep deprivation causes an increase in the activity of the sympathetic nervous system, resulting in overfeeding. In addition, elevation in the levels of cortisol and ghrelin, a hormone that stimulates hunger, and reduction in leptin, a hormone that stimulates satiety, can be the result of sleep deprivation.[14,15]

The Pittsburgh Sleep Quality Index (PSQI) is the most commonly used questionnaire for evaluating an individual's sleep quality and disturbances over the past month. It consists of several components, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction.[16] Several studies have been conducted to investigate the influence of sleep disorders on glycemic control. However, limited research has specifically examined the impact of disturbances in each subscale of the PSQI on glycemic control.

In the current study, we aimed to assess the sleep quality of adult patients with T2DM in Hamadan, Iran, and the association between sleep quality and glycemic control.

Materials and Methods

Study setting

This observational cross-sectional study was conducted at Shahid Beheshti Hospital in Hamadan, Iran from March 2020 to March 2021.

Sample size and sampling

Cochran's formula was used to calculate the sample size:

$$n = \frac{z^2 \times p(1-p)}{e^2}$$

where n is the required sample size, Z is equal to 1.96 for a 95% confidence level, e is the acceptable margin of error (0.05), and P refers to the estimated proportion of a specific disease in the population, which is usually determined from former studies (69% in this case based on a study performed by Farooque *et al.*).[17] The sample size required for the study, as calculated by the formula, was 163 individuals.

Data collection

The study population consisted of all adult patients with T2DM who were referred to the hospital during the study period. All diabetes patients who wanted to participate in this study were included, and those with a history of any respiratory diseases, chronic illnesses, psychiatric disorders, or use of psychiatric medications, sleeping pills, or illicit drugs were excluded from the study. The survey consisted of two parts. The first part included questions about the participants' demographic features such as gender, age, job, level of education, weight, height, location of residence (rural or urban), HbA1c level, and duration of diabetes. In the second part, participants completed the PSQI questionnaire, which is a self-rated questionnaire that evaluates adults' sleep quality and disturbances over the past month.

The PSQI questionnaire comprises 19 questions that are classified into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component has a score ranging from 0 to 3 that is interpreted as follows: no sleep problem: score of 0, mild sleep problem: score of 1, moderate sleep problem: score of 2, and severe sleep problem: score of 3. The global PSQI score is obtained by adding up all the component scores, ranging from 0 to 21. A PSQI score of 5 or higher indicates poor sleep quality.[16]

Data analysis

We employed SPSS. 21 for performing data analysis. Mean and standard deviation (SD) were used to describe the quantitative variables, while frequency represented as a percentage (%) was used to describe the qualitative variables. For data analysis, we employed *t*-tests and analysis of variance, and we considered *P* values lower than 0.05 to be statistically significant.

Ethical issues

We obtained approval from the institute's ethical committee [IR.UMSHA.REC.1399.428] prior to conducting the study. All participants were informed of the study's nature and purpose and provided their consent before participating.

Results

In total, 163 participants with T2DM participated in this study; their demographic characteristics are presented in Table 1.

Out of 163 participants, 95 (58.2%) had poor glycemic control (HbA1c ≥ 7%) and 68 (41.8%) had good glycemic control. Overall, 73 (44.8%) participants had poor sleep quality (global PSQI score > 5).

We found out that 28.4% of patients with good glycemic control had poor sleep quality, while this number was 55.8% among patients with poor glycemic control. Thus, patients who had poor glycemic control demonstrated a significantly greater rate of poor sleep quality compared to patients with good glycemic control ($P < 0.001$).

The frequency distribution of PSQI components is shown in Figure 1.

Out of 95 patients who had good glycemic control, the highest frequency was related to moderate sleep disturbances (35.7%), while in patients with poor glycemic control, the highest frequency was related to severe sleep disturbances (36.7%). Overall, patients with poor glycemic control exhibited significantly higher levels of sleep disturbances compared to those with good glycemic control ($P < 0.001$) [Table 2].

There was no statistically significant correlation between sleep quality and gender, education level, wake-up time, bedtime, and sleep duration ($P > 0.05$).

Logistic regression analysis of the relationship between poor glycemic control and each component of the PSQI questionnaire is shown in Table 3.

Table 1: Demographic characteristics of participants with type 2 diabetes mellitus (*n*=163)

Characteristic	Mean±SD	Range (Max–Min)	No. (%)
Age (years)	56.7±12.9	30–81	
Height (cm)	168.9±9.2	145–185	
Weight (kg)	83.9±11.6	50–104	
Sleep hygiene (different domains)			
BMI	26.22±1.95		
Wake-up time	8±1.74		
Bedtime	12±4.9		
Sleep duration	8±5.2		
HbA1c (%)	9.1±1.9	4–14	
Duration of diabetes (years)	13±6.5	2–31	
Male			101 (62%)
Female			62 (38%)
Education			
Illiterate			50 (30.7%)
primary school graduate			85 (52.1%)
high school graduate			23 (14.1%)
university-educated			5 (3.1%)

Table 2: Relationship between glycemic control and sleep problem severity in type 2 diabetes mellitus patients (*n*=163)

	HbA1c		P
	7< HbA1c	7≥ HbA1c	
	Frequency (%)	Frequency (%)	
No sleep problem	31 (32.6%)	12 (17.6%)	<0.001
Mild sleep problem	34 (35.7%)	14 (20.5%)	
Moderate sleep problem	20 (21%)	25 (36.7%)	
Severe sleep problem	10 (10.5%)	17 (25%)	
Total	95 (100%)	68 (100%)	

Table 3: Logistic regression analysis for different domains of sleep disturbance as predictors for poor glycemic control in type 2 diabetes mellitus patients (*n*=163)

Variables*	Odd ratio (95% CI)	*P*
Subjective sleep quality	5.67–12.8	0.005
Sleep latency	−0.19–10.29	0.5
Sleep duration	0.14–11.23	0.002
Habitual sleep efficiency	5.67–15.78	0.04
Use of sleeping medication	0.94–14.82	0.07
Daytime dysfunction	10.32–14.56	0.01

- All variables were considered as binary: good and poor;
- Poor situation for all of them considered as Referent

Discussion

The study aimed to assess the sleep quality of adult patients with T2DM and the association between sleep quality and glycemic control in some Iranian diabetic patients.

We found that nearly 50% of diabetic patients were suffering from poor sleep quality, and patients with poor glycemic control exhibited significantly higher levels of sleep disturbances compared to those with good glycemic control.

Diabetes mellitus poses a significant challenge in today's human society, especially in low-income countries such as those in the Middle East. It plays a crucial role in causing various issues in different organ systems.[18,19] The nervous system is particularly susceptible to the direct effects of T2DM, leading to organ deficiencies due to diabetes-related neuropathy.[20] Moreover, T2DM has the potential to induce significant defects in various centers of the brain. Studies have indicated a strong correlation between uncontrolled T2DM and sleep disorders.

While abundant evidence supports the link between T2DM and sleep disorders, it is crucial to acknowledge the bidirectional nature of this relationship.[19] Notably, sleep disorders can not only be a consequence of uncontrolled T2DM but also act as a contributing factor, potentially intensifying the progression of the condition.[19] This bidirectional dynamic operates through various mechanisms, including potential effects on insulin release, thus highlighting the complexity and mutual influence between T2DM and sleep disorders.[20,21] Given that T2DM is more prevalent and precedes sleep disorders, investigations typically prioritize T2DM as the primary culprit. Numerous studies conducted in different countries support this notion. For example, a study in Japan revealed that 47.6% of T2DM patients experienced sleep disorders (PSQI of > 5), while a study in Pakistan reported a higher percentage of 57%.[17,22]

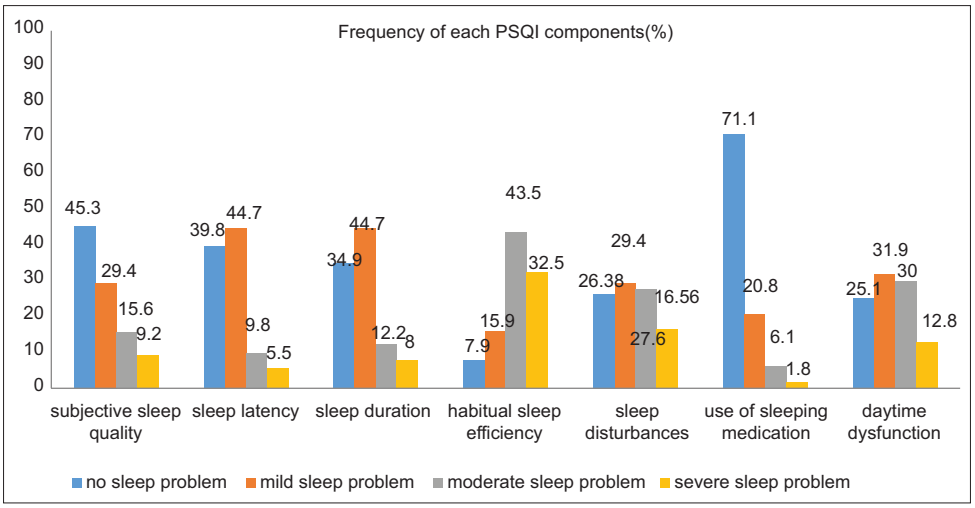

Figure 1: Distribution of sleep difficulties based on PSQI components in type 2 diabetes mellitus patients (n = 163)

In an endeavor to investigate the relationship between T2DM and sleep disorders, this research was carried out in Iran, situated in the MENA region. The study involved 163 individuals diagnosed with T2DM, comprising 101 (62%) men and 62 (38%) women, with an average age of 56.7 years. The evaluation involved the utilization of the PSQI questionnaire, which unveiled those 73 participants (44.8%) manifested indications of sleep disorders. This percentage notably surpassed the findings of a previous study conducted in the same country in 2012, which documented a 37% prevalence of sleep disorders.[23]

Breaking down the data further, it was observed that 58.2% of participants had good diabetes control (HbA1C < 7), and the occurrence of sleep disorders in this group was 28.4%. On the contrary, among those with poor diabetes control (HbA1C > 7), the occurrence of sleep disorders was higher at 55.8%. A comparison of these percentages revealed a risk ratio of 1.96, emphasizing the warning about the relationship between T2DM and its potential to induce sleep disorders.

A cross-sectional study with 1604 participants showed a robust correlation between sleep quality (PR = 1.40; 95%CI: 1.05–1.92) with T2DM.[24,25] Thus, in our research, various variables, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, and daytime dysfunction, were thoroughly examined. Our study, consistent with numerous previous investigations in this field, revealed that uncontrolled diabetes has a significant impact on sleep quality ($P < 0.005$), sleep duration ($P < 0.002$), and daytime dysfunction ($P < 0.01$).[24,25]

In addition, our research revealed a lack of a significant association between diabetes mellitus and sleep latency, contrary to findings in some other studies.[26] The observed mean BMI among our study participants, standing at 26.22 ± 1.95, is particularly noteworthy. This criterion alone has been shown to exert a substantial impact on the quality of sleep, a correlation substantiated by numerous studies conducted over an extended period.[27] While the overweight status can function as either a dependent or independent factor, it also holds the potential to act as a confounding variable, further emphasizing its multifaceted role in influencing sleep quality.

Conclusion

Overall, we can draw the conclusion that T2DM may exert a substantial influence on our sleep health and habits. This impact becomes particularly pronounced in patients who lack adequate care in managing their blood sugar levels.

Limitation

However, it is crucial to note that our study, given its limited participant pool, may not provide results that are entirely generalizable to the broader population on the flip side, it is essential to acknowledge that the data obtained in our study relied entirely on subjective assessments. This reliance on subjective reporting introduces a noteworthy element of bias that can significantly impact the robustness of our conclusions. The inherent subjectivity in the data collection process may lead to variations in individual interpretations, potentially influencing the accuracy and reliability of the findings.

In light of these limitations, the authors recommend conducting similar studies with larger participant samples. In addition to expanding the participant pool, employing comprehensive questionnaires and utilizing accurate and advanced facilities and equipment such as polysomnography for investigating the quality of patients' sleep can yield more valuable and reliable data for future studies. This approach would contribute to a more nuanced understanding of the intricate relationship between T2DM and sleep health, allowing for more robust conclusions and practical implications.

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Conflicts of interest

There are no conflicts of interest.

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