Sleeping Disturbances and Predictor Risk Factors among Type 2 Diabetic Mellitus Patients

Abdulbari Bener1,2,3, Abdulla O. A. A. Al-Hamaq1, Ahmet Faruk Agan4, Mustafa Öztürk3, Abdulkadir Ömer3

1Department of Biostatistics and Medical Informatics, Cerrahpasa Faculty of Medicine, Istanbul University, 2Department of Endocrinology, Medipol International School of Medicine, Istanbul Medipol University, 3Department of Biostatistics and Medical Informatics, Cerrahpasa Faculty of Medicine, Istanbul University and Istanbul Medipol University, International School of Medicine, 34098 Cerrahpasa, Istanbul, Turkey.

Abstract

Background: Sleep disturbance is a major health issue among people with type 2 diabetes mellitus (T2DM). The Pittsburgh Sleep Quality Index (PSQI) has been the most widely used instrument to measure subjective sleep disturbance. Aim: The aim of this study was to determine the impact of sleeping factor structure of the PSQI as potential predictor for glycosylated hemoglobin A1c (HbA1C) among people living with T2DM in the Turkish community to facilitate its use in the clinical practice and research. Subjects and Methods: This is a cross-sectional study and participants were between the age group of 25 and 65 years old who visited the diabetes and endocrinology department of Mega Medipol University Teaching Hospital, Istanbul. The PSQI was conducted on 871 patients with T2DM. Good sleep quality was defined as PSQI score <5. Multivariate logistic regression analysis was used to estimate the associated risk factors for the T2DM. Results: The current study showed significant differences between male and female patients with respect to their age in years, body mass index (BMI) (kg/m²), physical activity, smoking habit, sheesha smoking, income, family history of metabolic syndrome, coronary heart disease (CHD), and PSQI. The results revealed significant differences between HbA1c ≤7 and females and HbA1c >7 T2DM patients with respect to gender, BMI (kg/m²), CHD, and PSQI. The study demonstrated significant differences between sleeping categories PSQI as good, average, and poor sleeping among T2DM patients with respect to age and gender. Meanwhile, significant differences were reported between sleeping categories among T2DM patients with respect to their: number of sleeping hours, wake-up time, sleeping time, HbA1c, fasting blood glucose, uric acid, and systolic and diastolic blood pressure. This study showed very strong statistically significant correlations between low HbA1c and poor sleep quality in patients with T2DM patients, including subjective sleep quality r = 0.763, sleep latency r = 0.327, sleep duration r = 0.472, habitual sleep efficiency r = 0.575, sleep disturbances r = 0.564, use of sleep medication r = 0.728, and daytime dysfunction r = 0.734. Multivariate stepwise logistic regression analysis revealed that Vitamin D (mmol/L) (P < 0.001), HbA1c (P < 0.001), duration of DM (P < 0.001), uric acid (mmol/L) (P < 0.001), systolic blood pressure mmHg (P = 0.006), diastolic blood pressure mmHg (P = 0.015), and BMI (P = 0.024) were considered at higher risk as the predictors for sleeping quality among T2DM patients. Conclusion: The results suggest a strong positive correlation between PSQI with HbA1c levels, systolic and diastolic blood pressure, age, BMI, among type 2 diabetic patients. This study ascertains that poor sleep quality may be due to elevated level of HbA1c, metabolic syndrome, diabetes, obesity, and/or hypertension.

Keywords: Hemoglobin A1c, Pittsburgh Sleep Quality Index, risk factors, sleeping disturbances, type 2 diabetes mellitus

Résumé

Objectif: Le but de cette étude était de déterminer l’impact de la structure du facteur de sommeil du PSQI en tant que prédicteur potentiel de l’HbA1C chez les personnes vivant avec le DT2 dans la communauté turque afin de faciliter son utilisation dans la pratique clinique et la recherche. Méthodes: Il s’agit d’une étude transversale et les participants étaient âgés de 25 à 65 ans et ont visité le service de diabète et d’endocrinologie du Mega Medipol University Teaching Hospital, Istanbul. PSQI was conducted on 871 patients with T2DM. Good sleep quality was defined as PSQI score <5. Multivariate logistic regression analysis was used to estimate the associated risk factors for the T2DM. Results: The current study showed significant differences between male and female patients with respect to their age in years, body mass index (BMI) (kg/m²), physical activity, smoking habit, sheesha smoking, income, family history of metabolic syndrome, coronary heart disease (CHD), and PSQI. The results revealed significant differences between HbA1c ≤7 and females and HbA1c >7 T2DM patients with respect to gender, BMI (kg/m²), CHD, and PSQI. The study demonstrated significant differences between sleeping categories PSQI as good, average, and poor sleeping among T2DM patients with respect to age and gender. Meanwhile, significant differences were reported between sleeping categories among T2DM patients with respect to their: number of sleeping hours, wake-up time, sleeping time, HbA1c, fasting blood glucose, uric acid, and systolic and diastolic blood pressure. This study showed very strong statistically significant correlations between low HbA1c and poor sleep quality in patients with T2DM patients, including subjective sleep quality r = 0.763, sleep latency r = 0.327, sleep duration r = 0.472, habitual sleep efficiency r = 0.575, sleep disturbances r = 0.564, use of sleep medication r = 0.728, and daytime dysfunction r = 0.734. Multivariate stepwise logistic regression analysis revealed that Vitamin D (mmol/L) (P < 0.001), HbA1c (P < 0.001), duration of DM (P < 0.001), uric acid (mmol/L) (P < 0.001), systolic blood pressure mmHg (P = 0.006), diastolic blood pressure mmHg (P = 0.015), and BMI (P = 0.024) were considered at higher risk as the predictors for sleeping quality among T2DM patients. Conclusion: The results suggest a strong positive correlation between PSQI with HbA1c levels, systolic and diastolic blood pressure, age, BMI, among type 2 diabetic patients. This study ascertains that poor sleep quality may be due to elevated level of HbA1c, metabolic syndrome, diabetes, obesity, and/or hypertension.
Introduction
At present, many experimental and epidemiological studies have reported that poor sleep quantity and quality are related to the greater prevalence of high-fasting plasma glucose and high A1c level.[4-9] Most recently, systematic and meta analyses have reported that difficulties in both short and long durations of sleep are associated with the severity of diabetes.[5] Many studies provided evidence that sleep quality influences the glycemic control among type 2 diabetes mellitus (T2DM) patients and approximately 37%-50% of T2DM patients have sleep problems, which is higher than the general population.[6] Reduced sleep quality with low levels of slow-wave sleep, as occurs in many obese individuals, may contribute to the increased risk of T2DM and both sleep difficulties and poor sleep quality are thought to worsen diabetic symptoms.[7-9] Studies of sleep deprivation have indicated that disturbed or reduced sleep impair glucose tolerance and increases the risk of developing T2DM.[10-13]

Several epidemiological studies conducted on sleep disturbance in T2DM patients have been conducted in the Western countries.[15] Meanwhile, a study conducted in Japan has reported that those who had sleep disturbances were at a threefold risk of onset of T2DM.[14] The presence of sleep disorders in patients with T2DM causes worsening of glycemic control and increased risk for cardiovascular morbidity and mortality.[14,15] The objective of this study is to determine the prevalence and symptomatic characteristics of sleep disturbance among Turkish T2DM patients.

Subjects and Methods
This is a cross-sectional study and participants were patients aged 25-65 who visited the diabetes and endocrinology unit of Mega Medipol University Teaching Hospital, Istanbul. Data used in this report were used to investigate the relationship between sleep and glycemic control in people with T2DM.[15] A systematic random sample of 1,000 patients administered in the endocrinology unit in four general hospitals was recruited between January 2016 and April 2018, and 871 agreed and gave their consent to take part in this study, thus giving a response rate of 87.1%. The inclusion criteria were: (1) diagnosed with T2DM for over 3 years, additionally verified by the medical record, (2) aged 25 or over, and (3) able to communicate in Turkish. Participants were excluded if they had gestational diabetes, severe heart conditions, lung diseases, cerebral disease, and mental illness or disorders.

Laboratory measurements
People living with type two diabetes were considered as “case” patients if they had a history of DM and were taking any oral diabetes medications for at least a period of 3 years.[15] These “case” participants were investigated for their lipid profile (total cholesterol, low-density lipoprotein, high-density lipoprotein, and triglyceride), glycosylated hemoglobin A1c (HbA1c), postprandial glucose, blood pressure, serum creatinine, thyroid, and presence-related medical comorbidities. On the other hand, “control” subjects were not taking any DM medications and their HbA1c were <6.5% and their FPG were <7.0 mmol/L (126 mg/dL), which were confirmed by their medical records.[15]

Demographics and physiological parameters
This study was based on questionnaires, which assessed participant sociodemographics, physiological parameters and clinical and biochemistry parameters, blood pressure, and HbA1c. The level of HbA1c ≤7% was defined as good glycemic control based on the American Diabetes Association 2010 Guidelines while a level of HbA1c >7% was considered poor glycemic control.[15]

Pittsburgh Sleep Quality Index
The Pittsburgh Sleep Quality Index (PSQI) was developed by Buysse et al.[16] to evaluate subjective sleep disturbance over the past month. The questionnaire measures seven groups for sleep difficulty, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is scored on a 4-point Likert scale from 0 to 3, the sum of the seven components results a global PSQI score between 0 and 21. Based on the total PSQI score, patients were divided into three groups: the “Good sleep quality group” with PSQI score of ≤5: “Average sleep quality
group” with PSQI 6–8, and “Poor sleep quality group” with PSQI ≥9.[16,17] In that study, the internal consistency Cronbach’s a was 0.84, the split-half reliability was 0.87, and the 2-week test-retest reliability was 0.81. The PSQI had a sensitivity of 98.3% specificity of 90.2% when the cutoff point was set at 8. Higher scores indicate a lower SQ. A global PSQI score >5 has an 89.6% sensitivity and an 86.5% specificity in identifying patients with poor versus good SQ.[2,16,17]

The data were analyzed using the Statistical Package for the Social Sciences (IBM SPSS Statistics for Windows, version 22.0. IBM Corp., Armonk, NY, USA). Student-t test was conducted to reveal if any significant difference exists between the mean values of two continuous variables. One-way analysis of variance was employed for the comparison of more than two means. Fisher’s exact test (two-tailed) and Chi-square were employed to display the differences in the proportions of categorical variables between two or more groups. Multivariate logistic regression analysis was used to estimate the associated risk factors for sleeping among T2DM. Pearson correlation was performed to analyze the correlation analysis among total PSQI score, the seven components of the PSQI and the level of HbA1c. The level of statistical significance was considered

| Variables                                      | Gender                  |
|------------------------------------------------|-------------------------|
| Age groups (years)                             |                         |
| <40                                            | 66 (20.0)               |
| 40-49                                          | 79 (23.9)               |
| 50-59                                          | 77 (23.3)               |
| ≥60 and above                                  | 108 (37.7)              |
| Single                                         | 42 (12.7)               |
| Married                                        | 259 (78.5)              |
| Divorced/widow                                 | 29 (8.8)                |
| BMI (kg/m²)                                    |                         |
| Normal (<25 kg/m²)                             | 76 (23.0)               |
| Overweight (29-30 kg/m²)                       | 153 (46.4)              |
| Obese (>30 kg/m²)                              | 101 (30.6)              |
| Physical activity 30 min/day                   |                         |
| Yes                                            | 102 (30.9)              |
| No                                             | 228 (69.1)              |
| Household income                               |                         |
| Low                                            | 168 (50.9)              |
| Medium                                         | 103 (31.2)              |
| High                                           | 59 (17.9)               |
| Sheesha smoking                                |                         |
| Never                                          | 64 (19.4)               |
| Current smoker                                 | 266 (80.6)              |
| Cigarette smoking                              |                         |
| Never                                          | 262 (79.4)              |
| Current smoker                                 | 47 (14.2)               |
| Past smoker                                    | 21 (6.4)                |
| Family history of hypertension                 |                         |
| Yes                                            | 56 (17.0)               |
| No                                             | 274 (83.0)              |
| Metabolic syndrome ATP -III                    |                         |
| Yes                                            | 95 (28.8)               |
| No                                             | 235 (71.2)              |
| CHD                                            |                         |
| Yes                                            | 58 (17.6)               |
| No                                             | 272 (82.4)              |
| Sleep quality                                  |                         |
| Good (PSQI <5)                                 | 73 (22.1)               |
| Average (6 ≤ PSQI ≤8)                          | 112 (33.9)              |
| Poor (PSQI >8)                                 | 145 (43.0)              |

CHD=Coronary heart disease, PSQI=Pittsburgh Sleep Quality Index, BMI=Body mass index, ATP=Adenosine triphosphate

Table 1: Sociodemographic characteristics sleeping disorder studied by gender among type 2 diabetes mellitus patients (n=871)
as $P < 0.05$ for all tests.

**Results**

Table 1 findings showed significant differences between male and female patients with respect to their age in years, body mass index (BMI) (kg/m²), physical activity, smoking-habit, sheesha smoking, income, family history of metabolic syndrome, coronary heart disease (CHD), and PSQI.

Table 2 presents the sociodemographic and clinical characteristics sleeping quality by glycemic HbA1c level among T2DM patients. The results revealed significant differences between HbA1c ≤7 and females and HbA1c >7 T2DM patients with respect to gender, BMI (kg/m²), CHD, and PSQI.

Table 3 presents sociodemographic and clinical characteristics by PSQI as good, average, and poor sleeping among T2DM patients. The results showed significant differences between...
Bener, et al.: Sleeping disturbances and predictor risk factors in T2DM patients

Table 3: Comparison of sleeping quality among type 2 diabetes mellitus patients (n=871)

| Variables                                      | Good (PSQI<5) (n=253) | Average(6 < PSQI ≤8) (n=262) | Poor (PSQI > 8) (n=356) | P      |
|------------------------------------------------|------------------------|-------------------------------|--------------------------|--------|
| Age groups (years)                              |                        |                               |                          |        |
| <40                                           | 72 (28.5)              | 49 (18.7)                     | 93 (26.1)                | 0.001  |
| 40-49                                         | 53 (20.9)              | 84 (32.1)                     | 73 (20.5)                |        |
| 50-59                                         | 60 (23.7)              | 68 (26.0)                     | 71 (19.9)                |        |
| 60 and above                                   | 68 (26.9)              | 61 (23.3)                     | 119 (33.4)               |        |
| Gender                                         |                        |                               |                          |        |
| Male                                          | 73 (28.9)              | 112 (42.7)                    | 145 (40.7)               | 0.002  |
| Female                                         | 180 (71.1)             | 150 (57.3)                    | 211 (59.3)               |        |
| BMI (kg/m²)                                    |                        |                               |                          |        |
| Normal (<25 kg/m²)                             | 98 (38.8)              | 70 (26.7)                     | 87 (24.4)                | 0.003  |
| Overweight (29-30 kg/m²)                       | 99 (39.1)              | 127 (48.5)                    | 173 (67.6)               |        |
| Obese (>30 kg/m²)                              | 56 (22.1)              | 65 (24.8)                     | 96 (27.0)                |        |
| Physical activity                              |                        |                               |                          |        |
| Yes                                           | 75 (29.5)              | 60 (22.9)                     | 100 (28.1)               | 0.188  |
| No                                            | 178 (70.4)             | 202 (77.1)                    | 256 (71.9)               |        |
| Household income                               |                        |                               |                          |        |
| Low                                           | 52 (20.6)              | 73 (27.9)                     | 79 (22.2)                | 0.078  |
| Medium                                        | 144 (66.9)             | 152 (58)                      | 210 (59)                 |        |
| High                                          | 57 (22.9)              | 37 (14.1)                     | 67 (18.8)                |        |
| Smoking status                                 |                        |                               |                          |        |
| Never                                         | 219 (86.6)             | 221 (84.4)                    | 292 (82)                 | 0.576  |
| Current smoker                                 | 21 (8.3)               | 26 (9.9)                      | 44 (12.4)                |        |
| Past smoker                                    | 13 (5.1)               | 15 (5.7)                      | 20 (5.6)                 |        |
| Sheesha smoking status                         |                        |                               |                          |        |
| Yes                                           | 41 (16.2)              | 37 (14.1)                     | 55 (15.4)                | 0.800  |
| No                                            | 212 (83.8)             | 225 (85.9)                    | 301 (84.6)               |        |
| Metabolic syndrome ATP-III                     |                        |                               |                          |        |
| Yes                                           | 51 (20.2)              | 67 (25.6)                     | 97 (27.2)                | 0.125  |
| No                                            | 202 (79.8)             | 195 (74.4)                    | 259 (72.8)               |        |
| Family history of hypertension                 |                        |                               |                          |        |
| Yes                                           | 45 (17.8)              | 53 (20.2)                     | 64 (18)                  | 0.719  |
| No                                            | 208 (82.2)             | 209 (79.8)                    | 292 (82)                 |        |
| CHD                                           |                        |                               |                          |        |
| Yes                                           | 31 (12.3)              | 46 (17.6)                     | 45 (12.6)                | 0.139  |
| No                                            | 222 (87.7)             | 216 (82.4)                    | 311 (87.4)               |        |

CHD=Coronary heart disease, PSQI=Pittsburgh Sleep Quality Index, BMI=Body mass index, ATP=Adenosine triphosphate

Sleeping categories T2DM patients with respect to age in years, gender, and BMI.

Table 4 reports the baseline values of biochemical indices by PSQI among T2DM patients. Significant differences were reported between sleeping categories among T2DM patients with respect to their number of sleeping hours, wake-up time, sleeping time, HbA1c, fasting blood glucose, uric acid, and systolic and diastolic blood pressure.

This study demonstrated very strong statistically significant correlations between low HbA1c and poor sleep quality in patients with T2DM patients, including subjective sleep quality \( r = 0.763 \), sleep latency \( r = 0.327 \), sleep duration \( r = 0.472 \), habitual sleep efficiency \( r = 0.575 \), sleep disturbances \( r = 0.564 \), use of sleep medication \( r = 0.728 \), and daytime dysfunction \( r = 0.734 \).

Table 5 indicates multivariate stepwise logistic regression analysis of prognostic marker for the sleeping quality among T2DM patients. Vitamin D (mmol/L) \( P < 0.001 \), HbA1c \( P < 0.001 \), duration of DM \( P < 0.001 \), uric acid (mmol/L) \( P < 0.001 \), DBP mmHg \( P < 0.001 \), systolic blood pressure mmHg \( P = 0.006 \), diastolic blood pressure mmHg \( P = 0.015 \), and BMI \( P = 0.024 \) were considered at higher risk as a predictors of sleeping quality among T2DM patients.

**Discussion**

This study demonstrated that both poor sleep quality and less-efficient sleep are significantly correlated with worse glycemic control in patients with T2DM patients. The global PSQI score has good diagnostic sensitivity and specificity as
Table 4: Clinical biochemistry baseline value among type 2 diabetes mellitus patients (n=871)

| Variables                      | Good sleep (n=253) | Average sleep (n=262) | Poor sleep (n=356) | P   |
|--------------------------------|--------------------|-----------------------|--------------------|-----|
| Age (years)                    | 49.0±14.40         | 50.0±12.08            | 51.5±15.60         | 0.001|
| Number of sleeping hours       | 5.8±1.17           | 6.0±1.31              | 5.4±1.07           | 0.001|
| Wake-up time (AM)              | 6.75±0.76          | 6.79±0.89             | 6.60±0.87          | 0.016|
| Sleeping time (PM)             | 11.50±0.72         | 11.39±0.72            | 11.21±0.69         | 0.001|
| BMI (kg/m2)                    | 27.37±4.82         | 27.42±4.04            | 27.75±4.53         | 0.515|
| Diabetes duration in years     | 8.19±4.98          | 7.30±4.55             | 7.82±4.43          | 0.179|
| HbA1c                          | 7.19±0.72          | 7.47±0.90             | 7.59±0.86          | 0.001|
| Vitamin D (mmol/L)             | 17.60±6.27         | 16.14±6.77            | 16.47±6.31         | 0.031|
| Calcium (mmol/L)               | 1.73±0.43          | 1.66±0.45             | 1.76±0.68          | 0.092|
| Creatinine (mmol/L)            | 65.87±26.44        | 61.16±31.53           | 63.77±27.73        | 0.188|
| Fasting blood glucose (mmol/L) | 7.02±0.71          | 7.15±0.83             | 7.29±1.00          | 0.005|
| Cholesterol (mmol/L)           | 4.54±1.17          | 4.71±1.22             | 4.64±1.06          | 0.216|
| HDL (mmol/L)                   | 1.11±0.40          | 1.20±0.81             | 1.53±7.06          | 0.550|
| LDL (mmol/L)                   | 1.78±0.87          | 1.91±1.04             | 1.96±1.44          | 0.228|
| Triglyceride (mmol/L)          | 1.87±1.28          | 2.08±1.53             | 1.83±1.20          | 0.068|
| Uric acid (mmol/L)             | 265.10±63.77       | 271.52±58.17          | 282.11±58.43       | 0.002|
| Systolic blood pressure (mmHg) | 128.06±15.36       | 129.46±15.49          | 132.76±15.49       | 0.001|
| Diastolic blood pressure (mmHg)| 79.29±10.28        | 78.31±8.97            | 80.67±9.81         | 0.009|

HDL=High-density lipoprotein, LDL=Low-density lipoprotein, BMI=Body mass index, HbA1c=Glycosylated hemoglobin A1C, SD=Standard deviation

Table 5: Multivariate stepwise logistic regression analysis of prognostic marker for the sleeping quality among type 2 diabetes mellitus patients

| Independent variables                  | AOR   | 95% CI          | P    |
|----------------------------------------|-------|-----------------|------|
| Vitamin D deficiency (mmol/L)          | 3.38  | 2.32-5.70       | <0.001|
| HbA1c                                  | 3.20  | 1.95-5.19       | <0.001|
| Duration of DM                         | 3.13  | 1.89-4.92       | <0.001|
| Uric acid (mmol/L)                     | 2.95  | 2.13-3.98       | <0.001|
| Systolic blood pressure (mmHg)         | 2.74  | 1.86-3.91       | 0.006|
| Diastolic blood pressure (mmHg)        | 2.51  | 1.72-3.53       | 0.015|
| BMI                                     | 2.07  | 1.54-2.88       | 0.024|

DM=Diabetes mellitus, BMI=Body mass index, HbA1c=Glycosylated hemoglobin A1C, AOR=Adjusted odd ratios, CI=Confidence interval

a subjective method and may be useful to distinguish between good and poor sleepers. We also found positive correlations between a high level of HbA1c and duration of sleeping among T2DM patients.

Furthermore, other scientists reported strong positive relationships between the uric acid, PSQI, and HbA1c in T2DM patients. Finally, the prevention and early detection of elevated levels of uric acid in both T2DM and hypertensive patients can provide effective investigative tool in reducing CVD. Meanwhile, the PSQI questionnaire is well validated in the field, and it has high test-retest reliability and a good validity for persons with primary insomnia. It has been successfully used in T2DM patients. More recently, study and data suggest that poor sleep quality as measured by the Pittsburgh Sleep Quality Index (PSQI) contributes to suboptimal diabetes control. How the subscales comprising the PSQI individually relate to diabetes control is highly poor understood. The sleep disturbances subscale may drive the previously observed relationship between PSQI and HbA1c. In fact, the mechanism for the relationship between sleep disturbances and HbA1c was not presented very clearly in the literature, as does the impact on HbA1c of addressing sleep disturbances. We demonstrated very strong positive association between PSQI with HbA1c levels, systolic and diastolic blood pressure, age, BMI, among type 2 diabetic patients.

In the current study, diabetic patients reported the high prevalence of sleeping disorder among males (35.8%) and females (44.9%). This is in line with other studies conducted among male and female populations in the US, Japan, and in Qatar. This result supports the study finding of another study that sleep disorders correlates highly with obesity in the diabetic population. In the present study, a significant association was found between poor sleep and different comorbid factors such as metabolic syndrome and CHD, which were significantly higher among males than females.

This study is not without limitations. First, this is a cross-sectional design of the study which we cannot identify the causal relationship between the presence of sleep disturbance/insomnia symptoms and T2DM. Second, the sample of T2DM individuals was recruited from different hospitals, there may be sampling bias. Third, some patients might be affected with T2DM or associated with other diseases. Fourth, participants who had subjective sleep disturbance have not been clinically diagnosed but have been assessed by higher score of the PSQI.

**Conclusion**

The results suggest a strong positive correlation between PSQI
with HbA1c levels, systolic and diastolic blood pressure, age, BMI, among type 2 diabetic patients. This study ascertains that poor sleep quality may be due to elevated level of HbA1c, metabolic syndrome, diabetes, obesity, and/or hypertension. T2DM patients might suffer from sleep disturbance/insomnia symptoms and this could considerably reduce health-related quality of life.

Acknowledgment
This work was generously supported and funded by the Qatar Diabetes Association, Qatar Foundation. The authors would like to thank the Istanbul Medipol University for their support and ethical approval (Research Protocol and IRB# 10840098-604.01.01-E.8421 and Research Protocol and IRB# 10840098-604.01.01-E.40791).

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References
1. Aikens JE, Rouse ME. Help-seeking for insomnia among adult patients in primary care. J Am Board Fam Pract 2005;18:257-61.
2. Telford O, Diamantidis CJ, Bosworth HB, Patel UD, Davenport CA, Oakes MM, et al. The relationship between pittsburgh sleep quality index subscales and diabetes control. Chronic Illn 2019;15:210-9.
3. Shochat T, Umphress J, Israel AG, Ancoli-Israel S. Insomnia in primary care patients. Sleep 1999;22 Suppl 2:S359-65.
4. Yi-Wen T, Nai-Hsuan K, Tao HT, Chao YJ, Lin CJ, Chang KC, et al. Impact of subjective sleep quality on glycemic control in type 2 diabetes. Fam Pract 2012;29:30.
5. Cappuccio FP, D’Elia L, Strazzullo P, Miller MA. Quantity and quality of sleep and incidence of type 2 diabetes: A systematic review and meta-analysis. Diabetes Care 2010;33:414-20.
6. Nakajima H, Kaneita Y, Yokoyama E, Harano S, Tamaki T, Ibuka E, et al. Association between sleep duration and hemoglobin A1c level. Sleep Med 2008;9:745-52.
7. Shoji S, Mukai T, Uchimura N. Sleep disturbance in the diabetic patients. Prog Med 2004;24:987-92.
8. Tasali E, Leproult R, Ehrmann DA, Van Cauter E. Slow-wave sleep and the risk of type 2 diabetes in humans. Proc Natl Acad Sci U S A 2008;105:1044-9.
9. Arora T, Chen MZ, Cooper AR, Andrews RC, Taheri S. The impact of sleep debt on excess adiposity and insulin sensitivity in patients with early type 2 diabetes mellitus. J Clin Sleep Med 2016;12:673-80.
10. Møller JB, Pedersen M, Tanaka H, Ohsgui M, Overgaard RV, Lynge J, et al. Body composition is the main determinant for the difference in type 2 diabetes pathophysiology between Japanese and Caucasians. Diabetes Care 2014;37:796-804.
11. Narisawa H, Komada Y, Miwa T, Shikuma J, Sakurai M, Odawara M, et al. Prevalence, symptomatic features, and factors associated with sleep disturbance/insomnia in Japanese patients with type-2 diabetes. Neuropsychiatr Dis Treat 2017;13:1873-80.
12. Meisinger C, Heier M, Loewel H; MONICA/KORA Augsburg Cohort Study. Sleep disturbance as a predictor of type 2 diabetes mellitus in men and women from the general population. Diabetologia 2005;48:235-41.
13. Kawakami N, Takatsuka N, Shimizu H. Sleep disturbance and onset of type 2 diabetes. Diabetes Care 2004;27:282-3.
14. Kikuchi Y, Iwase M, Fujiy H, Okhuma T, Kaizu S, Ide H, et al. Association of severe hypoglycemia with depressive symptoms in patients with type 2 diabetes: the Fukuoka Diabetes Registry. BMJ Open Diabetes Res Care. 2015;3:e000063. doi: 10.1136/bmjdr-2014-000063.
15. Association AD. 1. Improving care and promoting health in populations: Standards of medical care in diabetes 2020. Diabetes Care 2020;43:S7-13.
16. Buyse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193-213.
17. Tsai YW, Kann NH, Tung TH, Chao YJ, Lin CJ, Chang KC, et al. Impact of subjective sleep quality on glycemic control in type 2 diabetes mellitus. Fam Pract 2012;29:30-5.
18. Bener A, Al-Hamaq AO. Sleep quality and excessive daytime sleepiness in an arab diabetic population. Biomed Res 2010;21:333-40.
19. Kachi Y, Nakao M, Takeuchi T, Yano E. Association between insomnia symptoms and hemoglobin A1c level in Japanese men. PLoS One 2011;6:e21420.
20. Bener A, Al-Hamaq AO, Ozurtuk M, Catan F, Haris P, Rajput KU, et al. Effect of Ramadan fasting and physical activity have effect on HbA1c, sleeping quality, blood pressure and BMI in Diabetes patients? Ann African Med 2018;17:196-202.
21. Backhaus J, Junghanns K, Broocks A, Riemann D, Hohagen F. Test-retest reliability and validity of the pittsburgh sleep quality index in primary insomnia. J Psychosom Res 2002;53:737-40.
22. Terzano MG, Parrino L, Cirignotta F, Ferini-Strambi L, Gigli G, Rudelli G, et al. Studio Morfeo: Insomnia in primary care, a survey conducted on the Italian population. Sleep Med 2004;5:67-75.
23. Sakamoto R, Yamakawa T, Takahashi K, Suzuki J, Shinoda MM, Sakamaki K, et al. Association of usual sleep quality and glycemic control in type 2 diabetes in Japanese: A cross sectional study. Sleep and food registry in Kanagawa (SOREKA). PLoS One 2018;13:e0191771.
24. Ayas NT, White DP, Al-Delaimy WK, Manson EJA, Stampfer JM, Speizer FE, et al. A prospective study of self-reported sleep duration and incident diabetes in women. Diabetes Care, 2003;26:380-384.