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Association between Quality of Sleep and its Effect on Glycaemic Control in Patients with Type 2 Diabetes Mellitus- A Pilot Study

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Introduction- Diabetes mellitus is a common metabolic disease. Nowadays, sleep complaints are increasing day by day due to the restriction in bed time resulting in chronic partial sleep loss.(1) Type 2 diabetes mellitus accounts for 95% of all of diagnosed diabetes worldwide. Several studies have recognized sleep disorder as a novel risk factor for diabetes.(2) Sleep disorder plays a vital role in the development of diabetes via various metabolic and neuroendocrine pathways.(3) Nocturia and neuropathic pain were explained as two possible causes of decreased sleep quality.(1) People who have sleep disorder either in the quality or quantity experienced reduced insulin sensitivity, which results in elevated blood glucose that can aggravate the progress of diabetes. There are limited studies from India on the association of sleep quality and diabetes control status. In this study, we aimed to find the quality of sleep in patients with type 2 diabetes mellitus and its correlation with glycaemic control.

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Association between Quality of Sleep and its Effect on Glycaemic Control in Patients with Type 2 Diabetes Mellitus- A Pilot Study

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I. Introduction

Diabetes mellitus is a common metabolic disease. Nowadays, sleep complaints are increasing day by day due to the restriction in bed time resulting in chronic partial sleep loss.[1] Type 2 diabetes mellitus accounts for 95% of all of diagnosed diabetes worldwide. Several studies have recognized sleep disorder as a novel risk factor for diabetes.[2] Sleep disorder plays a vital role in the development of diabetes via various metabolic and neuroendocrine pathways.[3] Nocturia and neuropathic pain were explained as two possible causes of decreased sleep quality.[1] People who have sleep disorder either in the quality or quantity experienced reduced insulin sensitivity, which results in elevated blood glucose that can aggravate the progress of diabetes. There are limited studies from India on the association of sleep quality and diabetes control status. In this study, we aimed to find the quality of sleep in patients with type 2 diabetes mellitus and its correlation with glycaemic control.

II. Material and Methods

It is a hospital record-based descriptive and cross-sectional analytical study involving patients with type 2 diabetes mellitus. The patients for the study were recruited from the outpatients and inpatients attending the Department of General Medicine of Sri Manakula Medical College and Hospital for a period six months after obtaining ethical committee approval.

Sample size: The sample size was determined by a single population- proportion formula with the assumptions of the 95% confidence level, 7.5% precision. The sample size was calculated for variables such as poor sleep quality, which is 33.8 %, and considering a 10% non-responses rate; the sample size was further increased to 160 respondents.[1]

Patients over 18 years old with a duration of diabetes more than one year were recruited for the study.

Patients with type 1 diabetes, gestational diabetes, or other specific types of diabetes, patients with acute diabetic complications, severe heart diseases, lung diseases, and cerebral diseases, patients with mental illness, and those with intelligence or cognitive impairment was excluded from the study.

Data collection procedure: Necessary data were collected in two stages. The details like demographic, risk factors, diabetic control, biochemical indicators HbA1c, complication, etc. were extracted in the questionnaire from the OPD and IP registration card. The patients fulfilling the inclusion criteria were recruited for the study after obtaining informed consent. Quality of sleep was measured using pittsburgh quality of sleep index, which measures seven components, which included subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction over the last one month.

Data analysis: As a first step, the frequency tables were obtained for discrete variables such as socio-demographic characteristics, risk factors, diabetic status, biochemical indicators, HbA1c, waist-hip ratio, and body mass index, and complications. Continuous variables were expressed as mean and standard deviation. Chi-square (x2) test was applied to proportions to find the level of significance which is fixed at $p<0.05$. Confidence interval (CI) set at 95%. Ethical principles such as respect for the persons, beneficence, justice, and ensuring confidentiality and privacy adhered to throughout the study. Ethical clearances was obtained from the institutional ethical committee.

III. Results

A total of 160 patients with type 2 diabetes mellitus were recruited for the study. The sociodemographic and clinical characteristics of the patients are shown in Table.1. The mean (SD) age of the patients was 55.5 (12.1%) years. One-fourth of patients had Diabetes Mellitus for more than five years. Almost three-fourth (117 patients) had uncontrolled PPBS, and three- fifths (94 patients) had uncontrolled FBS; in total, 79.4% (n=127) had an uncontrolled type 2 diabetes mellitus status. The proportion of patients with HbA1c > 6.1 was 91.9%. Quality of sleep was deficient in 18.1% (95% CI 12.5-24.9) (Figure.1). Around two-fifths (n=61, 38%) reported hypertension as co-morbidity.

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The correlation between PSQI with the duration of type 2 diabetes mellitus, FBS, PPBS and HbA1c are depicted in Table 2. There was a moderately positive correlation between PSQI score and PPBS (r=0.53) and low positive correlation for FBS (r=0.33) and HbA1c (r=0.49).

The association of age, gender, duration of diabetes, fasting, postprandial blood glucose, and Hba1c on sleep quality are shown in Table 3 and Table 4. Compared to a younger age group, diabetic patients aged 51-60 years had a higher risk of poor glycaemic control (aPR=1.34). Males had uncontrolled diabetes compared to females but were not found to be statistically significant (aPR=1.01, p=0.91). Having hypertension with type 2 diabetes mellitus had 1.16 times higher risk for poor glycaemic control. Type 2 diabetes mellitus duration for more than five years increases the chance of uncontrolled DM (aPR=1.21, p=0.02).

IV. Discussion

Short term studies have shown that disturbed or reduced sleep is associated with glucose intolerance and insulin resistance, thus predisposing the individual to type 2 diabetes mellitus. One potential mechanism includes reciprocal changes in circulating levels of leptin and ghrelin, which in turn increases appetite and obesity.[6] Sleep deprivation is said to decrease insulin production by increasing cortisol levels. Patients with diabetes tend to have many intrinsic and extrinsic sleep disorders.

This study was done to assess the quality of sleep and its relation with glycaemic control among type 2 diabetes mellitus patients using PSQI and the results showed that 18% of our study patients were having poor sleep (PSQI > 5), which is less than what other studies showed.[1] The mean (SD) of total PSQI score was 3.75 (2.7%), and this was similar to a study done in the USA by Luyster and Dunbar-Jacob.[7] But it was lower than other studies which reported a higher mean score of PSQI.[3-5] A meta-analysis conducted in 2010 reported poor sleep quality as a known risk factor for T2DM.[6] A study showed that a reduction of sleep by 2 hours for one week in young, healthy men and women were associated with a significant increase in the secretion of pro-inflammatory cytokines IL6 and TNF α which can lead to increased insulin resistance and cardiovascular disease.[8]

The current study showed a moderate positive correlation between PSQI score and HbA1c. Patients with high HbA1c levels tend to have increased symptoms such as thirst, nocturia, and neuropathic pain, which could lead to short sleep duration and poor sleep quality.[7] Similarly, poor sleep quality leads to elevation of the levels of cortisol, IL-6, and TNFα, resulting in activation of the sympathetic nervous system that promotes insulin resistance.[8, 9] Reduction in sleep duration may interfere the daytime activities and may prevent the patient from adherence to medications, diet and exercises. There is a need for more studies to understand the mechanisms underlying.

The present study indicated that 79% of the patient's glycaemic status were not under control (FBS>125mg/dl or PPBS>200mg/dl). These findings are similar to a large pan-India cross- sectional registry study conducted by Borgharkar et al. between 2015 and 2017.[10] Our results showed that only age, duration of diabetes, and poor sleep quality are the independent predictors of uncontrolled T2DM. These findings were in agreement with the results of some studies.[1, 11] Younger patients with diabetes mellitus (<50 years) were found to be associated with poor glycaemic control due to high insulin resistance.[14]

Our study found that duration of diabetes is one of the determinants of poor glycaemic control. A study conducted by Herrington et al. also identified the effect of long duration on poor glycemic control.[12] Deficient sleep quality is associated with a higher number of co-morbidities, higher number of diabetic complications and depression as reported by Luyster in his study.[7]

The limitations of this study could be that the majority of the study population were men (62%), and gender variations of sleep and diabetes are not adequately addressed. Only selective patients were questioned which may give results that might not be representative of the entire population with diabetes. Finally, no information on psychological parameters, type of medications, medication adherence, and comorbidities other than hypertension that might affect diabetes control was collected. No objective validation of sleep by means of polysomnography, EEG or EMG were done.

V. Conclusion

It is imperative to assess sleep in all patients with diabetes mellitus, and if needed a complete sleep study may be recommended. If identified, strategies to improve sleep quality and psychological consultation should be provided.

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Table 1: Sociodemographic and clinical details (N=160)

Variable	n	%
Age in years		
Up to 50	55	34.4
51-60	48	30.0
60 above	57	35.6
Gender		
Male	100	62.5
Female	60	37.5
Hypertension		
Yes	61	38.1
No	99	61.9
Diabetes duration		
Upto 5 years	119	74.4
More than 5 years	41	25.6
FBS control status		
Controlled	66	41.3
Uncontrolled	94	58.8
PPBS control status		
Controlled	43	26.9
Uncontrolled	117	73.1

Table 2: Correlation between PSQI with DM duration, FBS, PPBS, HBA1C (N=160)

Variable	Correlation coefficient
DM duration	0.141
FBS	0.327
PPBS	0.533
Hba1c	0.493

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Table 3: Association of sleep, Sociodemographic and clinical factors with FBS and PPBS (N=160)

Variable	T2DM		Crude PR	Adjusted PR	P value
	Uncontrolled (FBS>126/PPBS>183)	Controlled (FBS≤126/PPBS≤183)			
Age in year					
Up to 50 Years	48 (87.3)	7 (12.7)	1.26	1.34	0.01
51-60	33 (68.8)	15 (31.3)	1	1	-
60 above	46 (80.7)	11 (19.3)	1.17	1.14	0.252
Gender					
Male	80 (80.0)	20 (20.0)	1.02	1.01	0.91
Female	47 (78.3)	13 (21.7)	1	1	-
DM duration					
Up to 5 years	90 (75.6)	29 (24.4)	1	1	0.02
More than 5 years	37 (90.2)	4 (9.7)	1.19	1.21	-
Hypertension					
Yes	53 (86.9)	8 (13.1)	1.16	1.08	0.321
No	74 (74.7)	25 (25.3)	1	1	-
Sleep Quality					
Poor	27 (93.1)	2 (6.9)	1.22	1.17	0.022
Good	100 (76.3)	31 (23.7)	1	1	-

Table 4: Association of sleep, sociodemographic and clinical factors with HbA1c (N=160)

Variable	T2DM		Crude PR	Adjusted PR	P value
	Uncontrolled (Hba1c>6.1)	Controlled (Hba1c≤6.1)			
Age in year					
Up to 50 Years	53 (96.4)	2 (3.6)	1.08	1.14	0.039
51-60	43 (89.6)	5 (10.4)	1.01	1.02	0.290
60 above	51 (89.5)	6 (10.5)	1	1	-
Gender					
Male	93 (93.0)	7 (7.0)	1.03	1.02	0.697
Female	54 (90.0)	6 (10.0)	1	1	-
DM duration					
Up to 5 years	106 (89.1)	13 (10.9)	1	1	0.001
More than 5 years	41 (100.0)	0 (0)	1	1.14	-
Hypertension					
Yes	59 (96.7)	2 (3.3)	1.09	1.05	0.200
No	88 (88.9)	11 (11.1)	1	1	-
Sleep Quality					
Poor	29 (100)	0 (0)	1	1.08	0.014
Good	118 (90.1)	13 (9.9)	1	1	-

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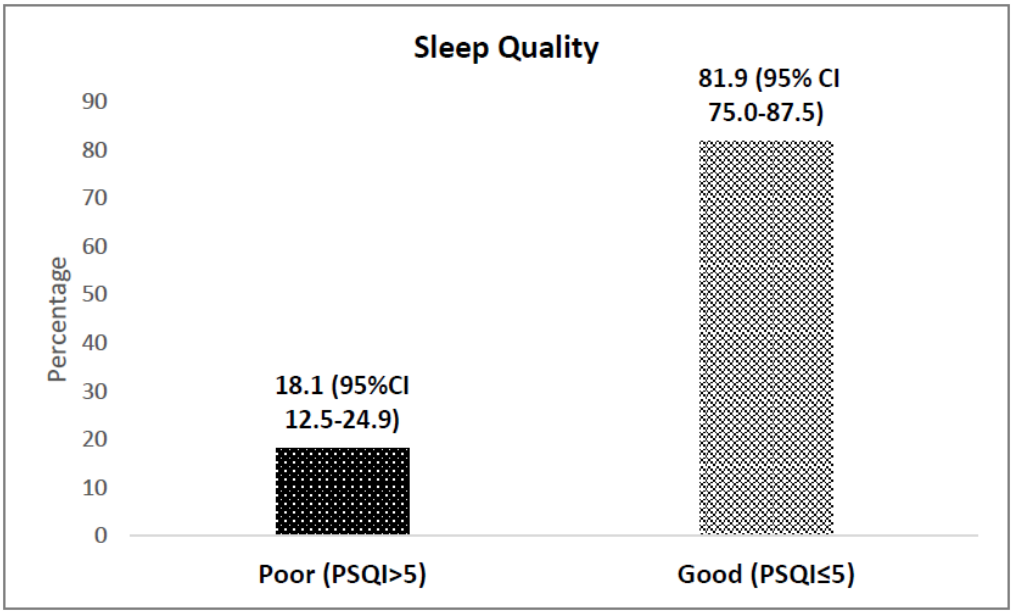

Figure 1: Prevalence of poor sleep among Type 2 Diabetes Mellitus patients

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