Comparison Of Quality Of Sleep Between Diabetic And Non-Diabetic Population Using Pittsburgh Sleep Quality Index

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Abstract

Background: Sleep is an essential event that affects the quality of life and hormonal balance in the human body. The association between sleep and diabetes is bi-directional.

Methods: This study was conducted with a case-control design in the Department of Medicine of Combined Military Hospital Peshawar between June 2022 to November 2022.

Results: The mean age of the study population was 51.1±12.94 years with 46% females and 54% males. The majority population was educated up to matriculation with a BMI in the normal (18.5-24.9 kg/m^2) range. There was no statistical difference in demographic data between the diabetic and control groups. Avg HbA1c was 8.546% ± 1.57% in the diabetic group and 5.712% ± 0.49% in the control group. As per the PSQI questionnaire, 47 (47%) participants were good sleepers across the study population, which included 17 out of 50 (34%) individuals in the diabetic and 30 out of 50 (60%) in the control group. This equated to a statistically significant difference between the two groups with a p-value of 0.007. A statistically significant difference (p = 0.001) was also seen in the PSQI score between diabetic and control groups (9.40 ± 5.82 vs 5.98 ± 4.85 respectively). Diabetics had 2.9 times odds (95% confidence interval 1.29-6.57, p = 0.01) of having bad quality sleep as compared to controls. In the diabetic group majority were males educated up to matriculate having medium adherence and treated with both oral hypoglycemic drugs and insulin having 3 or more comorbid conditions with hypertension being the most prevalent single comorbid disease.

Conclusion: By strict glycemic control in diabetics we can improve their quality of sleep Interventions to improve sleep hygiene can be suggested to patients by diabetes educators as part of diabetes self-management education programs.

Keywords: sleep quality, diabetes, non-diabetics

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1. Introduction

Diabetes mellitus is a metabolic disorder due to insulin under-production or abnormal functioning leading to increased blood glucose levels and abnormal carbohydrate, protein and lipid metabolism[1]. The alarming increase in Diabetes mellitus cases is a challenge for health professionals globally and according to the International diabetic federation, the expected number of people with Diabetes mellitus is expected to be 700 million by 2045[2]. The prevalence of Diabetes mellitus in Pakistan is 26.7%[3].

Sleep is an essential life event that affects the quality of life and approximately covers one-third of human life[4]. Different hormones are secreted during sleep which control body homeostasis[1]. There are many factors which affect sleep quality and duration ultimately resulting in poor quality of people[4]. Chronic disease also disturbs sleep quality and results in a high prevalence of sleep problems such patients 2.8%-17%[4].

The association between diabetes mellitus and quality of sleep is bi-directional[4,5]. Diabetes mellitus causes sleep disorders which in turn leads to poor glycemic control thus both disorders get worse with time and have a dramatic negative effect on a patient's quality of life[5]. Sleep disorders are a major undiagnosed and untreated health issue in diabetic patients[6]. Worldwide, 47% of the diabetic patients are suffering from sleep disorders[1]. The prevalence of poor sleep in diabetics ranges from 33.6% to 82.5%[4]. Different causes of sleep disorders in diabetics include restless leg syndrome, decreased pain sensation, reduced saturation level, night-time hyperglycemia and polyuria[1]. Abnormal sleep patterns are associated with an increased risk of new-onset type 2 Diabetes and complications5. Sleep disorders in diabetic patients lead to failure of treatment targets, impaired physical and mental capacity, and increased risk of cerebrovascular

accidents and mental illness. Fortunately, as evident from different studies sleep patterns can be improved resulting in good glycemic control and metabolism.[6] Assessment of sleep quality and timely intervention by health professionals should be adopted for achieving treatment goals in diabetic patients[1].

We carried out this study to compare the quality of sleep in diabetic patients and their attendants, to risk factors and association with glycemic control[7].

2. Materials & Methods

This study was conducted with a case-control design in the Department of Medicine of Combined Military Hospital Peshawar between June 2022 to November 2022. The study was conducted by the Helsinki Declaration after approval of the study design and methodology by the Ethical Committee of Combined Combined Military Hospital Peshawar between June 2022 to November 2022. All patients included in this study were inducted after verbal and written consent.

Patients included in this study were inducted from the medical outpatient department using non-probability consecutive sampling. Sample size calculation was done using OpenEpi Toolkit for case-control studies. We took the power of study at 80%, confidence interval of 95%, prevalence of diabetes at 26.7% in Pakistan (taken from Azeem et al) and odds ratio of 3.2 taken from Göçer et al in quality of sleep between non-diabetic and diabetic population, a sample size of 96 with 48 in each group was calculated[3, 8]. With an expected 10% failure to follow up, it was planned to indict 106 participants.

Inclusion Criteria: Adult individuals >18 years of age, with a diagnosis of diabetes mellitus fulfilling ADA diagnostic criteria, on or off treatment, with or without diabetic complications were inducted into study group[9]. Age matched control group was taken from normal individuals visiting the hospital as attendants of patients.

Exclusion Criteria: Patients excluded from the study were [(1)] patients with psychiatric illness or on psychiatric medications known to interfere with sleep [(2)] patients with disorders which cannot be explained as a risk factor or complication of diabetes mellitus [(3)] patients or individuals with a history of substance abuse including but not limited to cigarettes, alcohol, cannabis/cannabinoids, stimulants, narcotics, and sedatives [(4)] Pregnant females. In the control group, patients with any known history of chronic physical or psychiatric illnesses were excluded from the study.

All study participants were requested to either fill in a questionnaire or be interviewed to collect data. Demographic data, detailed history of diabetes, investigations to assess control of diabetes and the Pittsburgh Sleep Quality Index (PSQI) questionnaire were used as tools to collect data.

Participants were asked for demographic details including age, gender, education, marital status, height in meters, and weight in kilograms. A detailed history of diabetes mellitus was taken which included duration of illness, details of medication (oral drugs and insulin), adherence to medication and details of associated conditions and complications. BMI was calculated from height and weight and patients were classified into underweight (BMI $<18.5 kg/m^2$), normal (18.5-24.9 kg/m^2), overweight 25.0-29.9 kg/m^2) and obese ($\geq$30 kg/m^2). All study participants were asked to deposit blood samples to assess HbA1c levels and share either laboratory ID or results with the research team. Those individuals failing to follow up with either laboratory ID numbers or the result of HbA1c were excluded from the study.

Sleep quality was assessed by the Pittsburgh Sleep Quality Index (PSQI) questionnaire developed in 1989 by Buysse et al[10]. PSQI using a self-rated questionnaire aims to assess an individual's quality of sleep for the previous 1 month. It consists of nineteen questions for the patient and 5 for the patient's sleep partner in 7 defined components that evaluate an individual's sleep latency, subjective sleep quality, sleep disturbances, sleep duration, habitual sleep efficiency, daytime dysfunction, and use of sedative medications. All 7 components are marked 0-3 on a 4-point scale with a calculated maximum score of 21. Patients are marked to have "poor quality sleep" if the individual scores more than 5 on the PSQI questionnaire.

Microsoft Excel 365 was used to assess data. Categorical data was expressed as frequencies with percentages while nominal data was expressed as mean with standard deviation. The chi-square test was used to assess the relationship amongst categorical variables while the independent sample t-test was used to compare means between groups. The odds ratio was calculated to determine the relationship between the presence of diabetes and sleep quality. We used Pearson's correlation coefficient to calculate the relationship between normally distributed variables.

3. Results

Over 6 months 106 participants were inducted into the study, 54 in the diabetic group and 52 in the control group. 4 patients in the diabetic group and 2 from the control group failed to follow up with the research team with HbA1c report and thus were excluded from this study resulting in a sample size of 100 with 50 participants in both diabetic and control groups. The mean age of the study population was 51.1 ± 12.94 years with 46% females and 54% males. The majority population was educated up to matriculation with a BMI in the normal $(18.5\text{-}24.9 \text{ kg/m}^2)$ range. There was no statistical difference in demographic data between the diabetic and control groups. Detailed demographic characteristics of the study population are described in Table 1.

Avg HbA1c was $8.546\% \pm 1.57\%$ in the diabetic group and $5.712\% \pm 0.49\%$ in the control group. As per the PSQI questionnaire, 47 (47%) participants were good sleepers across the study population, which included 17 out of 50 (34%) individuals in the diabetic and 30 out of 50 (60%) in the control group. This equated to a statistically significant difference between the two groups with a p-value of 0.007. A statistically significant difference $(p = 0.001)$ was also seen in the PSQI scores between diabetic and control groups $(9.40 \pm 5.82 \text{ vs. } 5.98 \pm 4.85 \text{ respectively})$.

Diabetics had 2.9 times odds (95% confidence interval 1.29-6.57, $p = 0.01$) of having bad quality sleep as compared to controls. In the diabetic group majority were males educated up to matriculate having medium adherence and treated with both oral hypoglycemic drugs and insulin having 3 or more comorbid conditions with hypertension being the most prevalent single comorbid disease. Detailed data of the diabetic group is described in Table 2.

Table 1 Demographic details of the study population

		All Population	Diabetic Group	Control Group	p Value
		n ± Std deviation / n (%age)	n ± Std deviation / n (%age)	n ± Std deviation / n (%age)	
Age (years)		51.16 ± 12.93	50.48 ± 12.56	51.84 ± 13.15	0.286121
Gender (Males)		54 (54%)	26 (52%)	28 (56%)	0.299023
Education	Less than Primary	17 (17%)	7 (14%)	10 (20%)	0.090807
	Primary to up to matric	48 (48%)	24 (48%)	23 (46%)	
	Intermediate	16 (16%)	7 (14%)	9 (18%)	
	Bachelor or higher	19 (19%)	11 (22%)	7 (14%)	
HbA1c (%)		7.14 ± 1.84	8.57 ± 1.57	5.712 ± 0.49	
Sleep	Good	47 (47%)	17 (34%)	30 (60%)	0.007108
	Bad	53 (53%)	33(66%)	20 (40%)	
PSQI		7.64 ± 5.59	9.40 ± 5.82	5.98 ± 4.85	0.001048
BMI (kg/m^2)	<18	20 (20%)	9 (18%)	10 (20%)	0.424819
	18-24.9	41 (41%)	22 (44%)	23 (46%)	
	25-29.9	23 (23%)	11 (22%)	9 (18%)	
	≥30	16 (16%)	9 (18%)	7 (14%)	

(Abbreviations used above OAH-oral antihyperglycemic, CKD- chronic kidney disease, HTN- Hypertension, IHD-Ischemic Heart disease, CVA- cerebrovascular accidents)

Correlation calculation was done in all population and individual groups separately. Overall, a positive correlation through Pearson r was noticed measuring 0.47 was seen between absolute values of HbA1c and PSQI score (figure

I), while a negative correlation measuring -0.34 was seen between quality of sleep and HbA1c. A positive correlation measuring 0.21 was measured between BMI and PSQI score across the population while no correlation was seen between age and PSQI score, and Gender and PSQI.
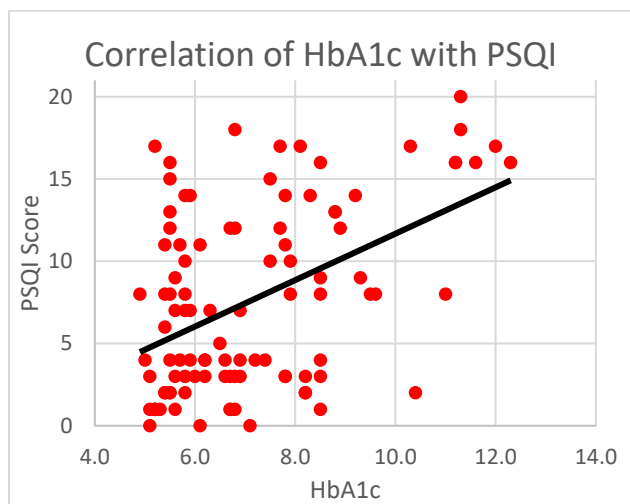

Figure-1 Correlation between HbA1c and PQSI

Table 2 Details of the Diabetic group

		Diabetic Group
		n ± Std deviation / n (%age)
Duration of DM (years)		6 ± 3.06
MMA	Low Adherence	13 (26%)
	Medium Adherence	19 (38%)
	Good Adherence	18 (36%)
Treatment	None	14 (28%)
	OAH only	13 (26%)
	Insulin only	7 (14%)
	Both	16 (32%)
Comorbid	CKD	12 (24%)
	Htn	25 (50%)
	IHD	13 (26%)
	Cataract	18 (36%)
	CVA	10 (20%)
	3 or more	25 (50%)

The correlation coefficient was also calculated in individual groups (values given in Table 3). A positive correlation of 0.50 was seen between the absolute value of HbA1c and PQSI in the diabetic group while this value was -0.03 in controls signifying a positive correlation between HbA1c and PQSI only in the diabetic population.

Table 3 Correlation coefficient between PQSI and various variables

		All Population	Diabetic Group	Control Group
Age		0.01	0.07	-0.04
Gender		0.08	0.00	0.23
Education		-0.15	-0.34	-0.02
HbA1c		0.47	0.50	-0.03
BMI		0.21	0.18	0.28
Duration of Diabetes			0.18	
Medication Adherence			-0.37	
On Treatment	Oral drugs		-0.23	
	Insulin		-0.15	
Comorbid	CKD		0.40	
	Hypertension		0.14	
	IHD		0.21	
	Cataract		0.03	
	CVA		0.10	

5. Discussion

Sleep is a physiological requirement for the healthy functioning of the human mind and body. It is generated in the body based on a circadian rhythm after a period of wakefulness. Poor or impaired sleep is associated with various health conditions, poor work performance and occupational accidents. Patients with DM can have difficulties in their sleep and wakefulness due to multifactorial problems and co-morbid sleep pathologies. In this study, we attempted to evaluate the sleep quality of patients with diabetes and its effect on glycemic control.

Diabetes mellitus is a chronic condition of a public health concern due to its high morbidity and mortality and significant loss of quality of life. The prevalence of diabetes is 26.7% in our setup and further on the rise[3]. It bears a huge burden on the physical, mental and financial condition of the patients. Studies have shown that poor sleep quality is a significant predictor of lower health-related quality of life in patients with diabetes as indicated by lower scores on both the

physical and mental scales[11]. In a study with 944 participants, poor sleep quality in patients with diabetes was positively associated with a lower health-related quality of life (OR: 3.67, 95% CI: 1.30–10.33, P < 0.001)[12]. This has generated an interest in the effect of sleep on diabetes and much research is being conducted to explore sleep-related interventions to optimize glycemic control and improve quality of life in this group.

The management of diabetes is multi-dimensional and requires commitment from both the patient and caretakers and the healthcare providers. In a literature review of sleep in type 1 DM Inconsistent sleep timing (bedtime and wake time) has emerged as a potential target for interventions, as variability in sleep timing has been linked with poorer glycemic control and adherence to treatment[13]. This study explored the effect of a simple parameter like sleep quality on glycemic control to incorporate healthy sleep patterns as a cost-free and easy intervention in the management of all patients with diabetes.

This study found a statistically significant difference in the sleep quality of cases with diabetes as compared to the control group. Only 34% of the cases in the group with diabetes had good sleep while 66% had poor sleep quality according to scores on the PSQI (p value= 0.001). In a research poll conducted at the University of Pittsburgh more than half of the patients with type 2 DM are likely to report being "poor sleepers" with high scores on PSQI[10]. Luyster et all studied sleep patterns in 300 patients with diabetes and 55% were poor sleepers according to the PSQI[11]. Likewise in a study by Cunha et al, 52 percent (n=25) of patients with diabetes had poor sleep quality scores on PSQI[14]. The numbers in these studies are comparable to ours. Another study has also shown that up to one-third of patients with DM suffered from concomitant sleep disorders, as compared with 8.2% of controls without DM[15].

A statistically significant difference (p = 0.001) was seen in the PSQI score between diabetic and control groups (9.40 ± 5.82 vs 5.98 ± 4.85 respectively) in this study. These scores are similar to that of another study by Lydi Ann et which showed a PSQI of 7.2±3.5 in patients with diabetes compared to a score of 5.4±3.5 in the control group. p=0.0024[16].

In this study, a positive correlation (Pearson r of 0.47) was seen between absolute values of HbA1c and PSQI score, while a negative correlation of -0.34 was seen between quality of sleep and HbA1c. Similarly, a meta-analysis of 20 studies revealed that Short and long sleep durations were associated with an increased haemoglobin A_{1c} (HbA1c) (weighted mean difference (WMD): 0.23% [0.10–0.36], short sleep; WMD: 0.13% [0.02–0.25], long sleep) compared to normal sleep and that poor sleep quality was associated with an increased HbA1c[17]. In another study of 191 patients aged 16.5 years (mean HbA1c 8.0%) sleep quality was significantly associated with HbA1c (mean difference; $\beta = -0.07$, P = .05)[18].

In this study, a difference of 1.2 (7.8 vs 9.0, p=0.004) in HbA1c was seen in the diabetic group between good sleepers and poor sleepers. Similarly, in a prospective study of 266 cases, it was found that For patients with the same level of age, sex, BMI, and diabetes-related complications, the mean HbA1c level was 0.621 (SD = 0.21) units lower in good sleepers than in poor sleepers (p=0.003)[19]. In another study, Poor sleep efficiency and later bedtime routines are associated with more pronounced postprandial glycemic responses to breakfast the following morning. A larger between-person Sleep efficiency was significantly associated with lower glucoseiAUC0-2h ($\beta SE = -10.48$ [95% CI −19.85, −1.11], pSE = 0.028)[20]. In a meta-analysis of 22 studies Adults with TID who reported sleeping >6 hours had lower haemoglobin A1c (HbA1c) levels than those sleeping ≤6 hours (MD = -0.24%; 95% CI = -0.47, -0.02), and participants reporting good sleep quality had lower HbA1c than those with poor sleep quality (MD = -0.19%; 95% CI = -0.30, -0.08)[21].

In a study by Chasens et al, of the 3 factors of the PSQI, only the Daily Disturbances factor was significantly associated with increased diabetes control problems. In the same study, Poor sleep quality was associated with significantly worse scores on the Diabetes Care Profile scales, with poorer glycemic control, lower self-care adherence, and decreased adherence to dietary adherence[22].

A positive correlation measuring 0.21 was measured between BMI and PSQI score across the population while no correlation was seen between age and PSQI score, and Gender and PSQI. A similar positive

correlation with BMI and no correlation with age and gender were also seen in another study[23]. Obesity is well known to be associated with sleep disturbances [24].

This study confirms the presence of sleep abnormalities in subjects with diabetes and ascertains their negative effects on glycemic control. Our study has limitations as it had a small sample size and we did not explore the effect of altered sleep on the quality of life of patients with diabetes. Based on the findings in this study further research can be done in the area and sleep-related interventions can be used as a strategy to optimize medical care of patients with diabetes. Preliminary evidence already supports sleep interventions (e.g., sleep extension and sleep coaching) in improving sleep and glycemic control[25].

5. Conclusion

It is important for the health care providers treating patients with DM to address their sleep issues and impaired quality of life due to inadequate and fragmented sleep, as it may be severely affecting their recovery, control of diabetes as well and quality of life. Interventions to improve sleep hygiene can be suggested to patients by diabetes educators as part of diabetes self-management education programs.

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M.H, F.A.S, W.A, S.R, M.S.A - Conception of study
B.S, F.A.S - Experimentation/Study Conduction
F.A.S, M.H, W.A, S.R, M.S.A - Analysis/Interpretation/Discussion
B.S, F.A.S, M.H, W.A, M.S.A - Manuscript Writing
B.S, M.H, W.A, S.R, M.S.A - Critical Review
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