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Original Article

Association between Sleep Quality and Glycaemic Control, Quality of Life, Obesity and Other Metabolic Risk Factors among Patients with Diabetes Mellitus

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Abstract

Introduction:
Diabetes mellitus is a growing public health challenge in Southeast Asia, with rising concerns about factors influencing its management beyond conventional treatments. While sleep quality has been linked to metabolic health in various populations, its impact on glycemic control and related parameters in Sri Lankan individuals living with diabetes remain unexplored.

Objective:
To explore the association between sleep quality, glycemic control, and other metabolic parameters (obesity, hypertension, and diabetes-related quality of life) in patients with diabetes in Sri Lanka.

Methods:
A descriptive cross-sectional study was conducted among 220 adult patients with diabetes attending diabetes clinics at the National Hospital of Sri Lanka. Sleep quality was measured with the Pittsburgh Sleep Quality Index (PSQI), while glycemic control was measured with HbA1c levels. Metabolic parameters, including body mass index (BMI), blood pressure, and diabetes-related quality of life (DQoL), were also evaluated. Data were analyzed using descriptive statistics, correlation analysis, and linear regression.

Results:
The mean age of participants was 60.37±10.3 years, with 97.7% diagnosed with type 2 diabetes. The mean HbA1c was 8.3±2.2%, and 36.8% of patients reported poor sleep quality (PSQI > 5). Sleep quality showed a significant positive correlation with DQoL ($r = 0.197$, $p = 0.003$) and higher PSQI was associated with poorer glycemic control in adjusted linear regression ($B = 0.09$, $p = 0.05$). Additionally, poorer sleep quality was linked to an increased likelihood of hypertension ($Exp(B) = 1.12$, $p = 0.033$), although no significant association was found with obesity.

Conclusion:
The findings suggest that poor sleep quality is associated with worse glycemic control, hypertension, and lower quality of life in Sri Lankan diabetes patients. These results emphasize the need to consider sleep quality as an integral part of diabetes management. Further studies are needed to examine causal links and explore the potential benefits of sleep interventions in this population.

Keywords: Diabetes, sleep quality, glycaemic control

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Introduction

Diabetes mellitus has become a significant global health challenge, with its prevalence in Southeast Asia projected to increase by 68%, reaching 152 million cases by 2045[1]. While lifestyle modifications and pharmacological therapy remain central to diabetes management, emerging research suggests that factors such as sleep quality may also influence disease control. However, the impact of sleep on diabetes management remains poorly understood, with some studies indicating a relationship between poor sleep quality and impaired glucose control, while others do not.

Experimental studies have indicated that sleep deprivation can lead to glucose intolerance[2]. In one such study, sleep was restricted for 2 days, followed by 2 days of sleep extension, which resulted in significantly higher serum glucose levels and lower insulin levels during the sleep restriction period compared to the sleep extension phase[3]. Epidemiological studies have also linked insufficient or poor-quality sleep with an increased risk of diabetes[4,5,6]. However, other studies have not demonstrated this association[7,8].

Several cross-sectional studies have examined the relationship between sleep duration and quality with glycemic control, but the results have been inconsistent[9,10,11,12,13]. A meta-analysis encompassing 20 studies showed that both short and long sleep durations were associated with higher HbA1c levels, indicating a U-shaped relationship[14]. Furthermore, poor sleep quality was also associated with elevated HbA1c levels. In a study from South India, high rates of sleep dysfunction were reported among diabetes patients, but no significant correlation with glycemic control was found[15]. To date, no studies from Sri Lanka have specifically examined the association between sleep dysfunction and glycemic control in diabetic patients. This study aims to explore the relationship between sleep quality, glycemic control, and other metabolic parameters in Sri Lankan diabetes patients.

Materials and methods

This cross-sectional observational study was conducted among adult patients attending the diabetes clinic at the National Hospital of Sri Lanka, Colombo. The main objective was to investigate the link between sleep quality and glycemic control, while secondary objectives included assessing associations between sleep quality and obesity, hypertension, and diabetes-related quality of life (DQoL).

The study was approved by the Ethics Review Committee of the Faculty of Medicine, University of Colombo (ERC reference number EC-22-028), and informed consent was obtained from all participants.

Exclusion criteria were significant co-morbidities that limit participant's ability to respond to the interviewer administered questionnaire, inability to speak one of the three languages: Tamil, Sinhala or English and those without HbA1c reports within one year.

A trained medical graduate administered the structured questionnaire, which was available in English, Tamil and Sinhala. The questionnaire assessed self-reported duration of sleep and sleep quality according to Pittsburgh Sleep Quality Index (PSQI)[16]. The questions included basic demographic parameters, social determinants of health, duration of diabetes, presence of other metabolic risk factors and cardiovascular disease, PSQI and other relevant health information. Diabetes quality of life was assessed using a revised version of diabetes quality of life (DQoL) instrument[17]. Patient's weight, height waist circumference and blood pressure were measured.

Sleep Quality: Sleep quality was assessed using the PSQI, a validated tool with 19 questions that assess seven sleep-related domains. The global score ranges from 0 to 21, with higher scores indicating worse sleep quality. A PSQI score greater than 5 was classified as poor sleep quality. The PSQI has undergone validation in Sri Lankan population, demonstrating high internal consistency with a Cronbach's alpha of 0.85[18].

Diabetes Quality of Life (DQoL): The revised DQoL scale evaluates three domains: satisfaction, impact, and worry. Scores are converted into percentages, with higher values reflecting a worse quality of life.

Metabolic Parameters: HbA1c was extracted from clinic records. Obesity was defined as a BMI ≥ 25 kg/m², as per Sri Lankan cutoff values[19]. Hypertension was defined as systolic blood pressure > 140 mmHg and/or diastolic blood pressure > 90 mmHg, or use of antihypertensive medication. Good blood pressure control was defined as systolic BP $\leq$ 140 mmHg and diastolic BP $\leq$ 90 mmHg. Glycemic control was categorized as HbA1c $\leq$ 7% and > 7%.

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics (percentages and means) were used, and independent sample t-tests, Spearman correlation analysis, and Chi-square tests were conducted to assess relationships between variables.

Results

Data was collected from 220 patients: 123 (55.9%) were female, and 97 (44.1%) were male, with a mean age of 60.37±10.3 years. The majority (96.4%) were from the Western Province of Sri Lanka, primarily from Colombo (75%), followed by Gampaha (16.8%) and Kalutara (4.5%) districts. Mean monthly income was 57,659±32,542 rupees. Education level of patients was as follows; no formal education – 11 patients (5%), grade 5 or below – 9 patients (4.1%), grade 5 to 11 – 60 patients (27.3%), passed ordinary level – 72 patients (32.7%), passed advanced level – 51 patients (23.2%), graduate – 15 patients (6.8%), vocational – 2 patients (0.9%).

The cohort had a mean BMI of 25.35±3.8 kg/m², and 50.9% were classified as obese. Mean waist circumference was 87.04±6.1 cm. Of the 220 participants, 97.7% had type 2 diabetes, and 2.3% had type 1 diabetes. The mean HbA1c level was 8.3 ± 2.2%, with 30.7% of patients achieving good glycemic control (HbA1c $\leq$ 7%). Mean duration of diabetes was 9.99 ± 8.1 years. One hundred and sixty-nine patients (77.2%) were on oral hypoglycemic drugs (OHD) only and 47 patients (21.5%) were on OHD and insulin. Three patients (1.4%) were on insulin only. Forty-one patients (18.7%) were on 1 OHD and 72 patients (32.9%) were on 2 OHDs. One hundred patients (45.7%) were on 3 OHDs and 3 patients (1.4%) were on 4 OHDs. Mean number of OHDs was 2.27±0.8. One hundred and fifty-six patients (70.9%) had hypertension. Out of these patients 123 (78.8%) had good blood pressure control.

Table 1: Demographic and Clinical Characteristics of Study Participants (BMI – Body Mass Index, PSQI - Pittsburgh Sleep Quality Index, OHD – Oral hypoglycaemic drug, SD – Standard deviation)

Variable	Total (N = 220)	Female (N = 123)	Male (N = 97)	p-value
Age in years (mean ± SD)	60.37±10.3	59.75±10.5	61.00±10.1	0.357
Body Mass Index (BMI) kg/m^2(mean ± SD)	25.35±3.8	25.67±4.0	24.94±3.5	0.160
Sleep Duration, minutes (mean ± SD)	393.56±93.7	392.19±91.3	395.28±97.0	0.808
PSQI Score (mean ± SD)	4.71±3.3	4.89±3.4	4.49±3.1	0.367
HbA1c, % (mean ± SD)	8.3±2.2	8.62±2.3	7.88±1.9	0.016
Hypertension Prevalence (%)	70.9%	69.9%	72.1%	0.416
Obesity Prevalence (%)	50.9%	53.66%	47.4%	0.217
Diabetes Duration, years (mean ± SD)	9.99±8.1	11.07±8.5	8.62±7.4	0.040
Number of OHDs (mean ± SD)	2.27±0.8	2.35±0.8	2.16±0.8	0.096
Income, Rupees (mean ± SD)	57,659±32,542	55691.06±34831.7	60154.64±29372.3	0.314

Sleep Duration and Quality: The mean sleep duration was 393.56±93.7 minutes, with 6.4% of patients sleeping less than 4 hours, 35.9% sleeping 4–6 hours, 44.1% sleeping 6–8 hours, and 13.6% sleeping more than 8 hours. The mean PSQI score was 4.71±3.3, with 36.8% of patients reporting poor sleep quality (PSQI > 5). Mean DQoL was 41.54±4.1%. The high prevalence of poor sleep quality (36.8%) among this cohort underscores the need for addressing sleep issues in diabetes care.

An independent t-test revealed no significant difference in sleep quality between females (mean 4.89±3.4) and males (mean 4.49±3.1) ($p = 0.620$). A one-way ANOVA indicated no significant differences in sleep quality scores across different education levels ($p = 0.113$).

Sleep Quality and Glycemic Control: A Spearman correlation analysis showed a negative, but non-significant, correlation between sleep duration and HbA1c ($r = -0.062$, $p = 0.367$). Similarly, no significant correlation was found between PSQI scores and HbA1c ($r = 0.08$, $p = 0.24$). However, linear regression analysis showed that PSQI was significantly associated with HbA1c ($B = 0.09$, $p = 0.05$), indicating that poorer sleep quality might be linked to worse glycemic control when adjusting for age, BMI, gender, and diabetes duration. The model explained 12% of the variance in HbA1c ($R^2 = 0.12$, $p < 0.001$). Additionally, age ($B = -0.05$, $p < 0.001$) and BMI ($B = -0.09$, $p = 0.01$) were significant predictors of HbA1c, while diabetes duration was not ($p = 0.42$).

Sleep Quality and Hypertension: Poor sleep quality was more prevalent among patients with hypertension (40.4%) than those without (28.1%), though this difference was not statistically significant ($\chi^2 = 2.932$, $df = 1$, $p = 0.087$). Logistic regression revealed a positive association between sleep quality and hypertension ($Exp(B) = 1.12$, $p = 0.033$), with poor sleep quality increasing the likelihood of hypertension.

Sleep Quality and Obesity: There were no significant correlations between sleep quality or duration and BMI, although a small positive correlation was observed between PSQI and BMI ($r = 0.048$, $p = 0.480$).

Sleep Quality and DQoL: There was a statisctically significant weak positive correlation between PSQI and DQoL ($r = 0.197$, $p = 0.003$), indicating that poorer sleep quality was associated with worse quality of life. We found a statistically significant weak negative correlation between sleep duration and DQoL ($r = -0.132$, $p = 0.05$), suggesting that longer sleep duration may be associated with a better quality of life.

Table 2: Regression table for linear regression between HbA1c and PSQI score, age, BMI, sex and diabetes duration

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	14.453	1.390		10.398	.000
	GPSQI	.090	.046	.131	1.932	.055
	Age	-.055	.015	-.256	-3.755	.000
	BMI	-.096	.038	-.166	-2.533	.012
	Sex	-.663	.298	-.147	-2.223	.027
	DM_Duration	.016	.019	.057	.806	.421

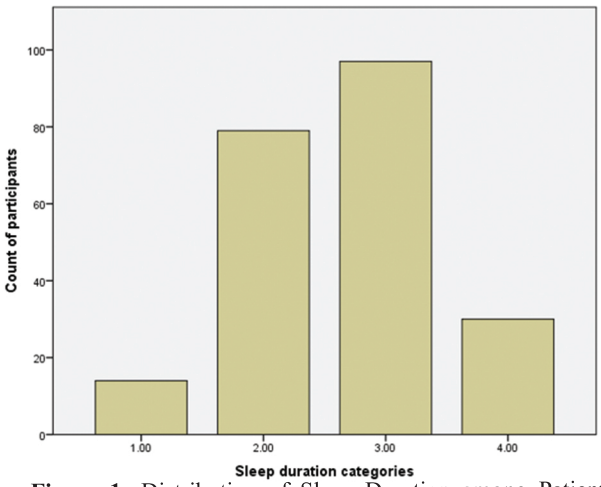

Figure 1: Distribution of Sleep Duration among Patients (Category 1 - < 4 hours, Category 2 - 4–6 hours, Category 3 - 6–8 hours, Category 4 - > 8 hours)

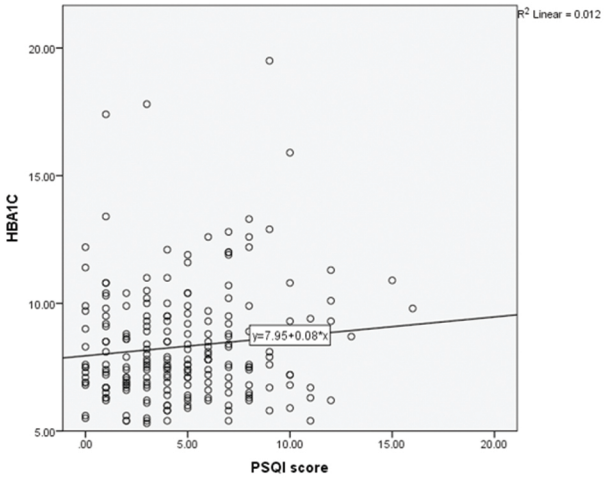

Figure 2: Correlation between PSQI Score and HbA1c (PSQI - Pittsburgh Sleep Quality Index)

Table 3: Regression table for linear regression between DQoL and PSQI score, age, BMI, sex, diabetes duration, income and presence of hypertension

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	22.396	2.656		8.433	.000
	GPSQI	.255	.089	.202	2.853	.005
	Age	-.028	.028	-.071	-1.008	.315
	BMI	-.012	.073	-.012	-.167	.867
	Sex	.205	.559	.025	.367	.714
	DM_Duration	.038	.037	.076	1.037	.301
	Income	1.007E-5	.000	.080	1.185	.237
	HTN_Cat	.531	.628	.059	.845	.399

Table 4: Association between Sleep Quality (PSQI) and Glycemic Control, Hypertension, and Obesity (PSQI - Pittsburgh Sleep Quality Index, BMI – Body mass index, DQoL - Diabetes Quality of Life)

Outcome Variable	PSQI Score (Mean ± SD)	Correlation Coefficient (r) / p-value (for continuous outcomes)	Chi-Square / p-value (for categorical outcomes)
HbA1c (Spearman correlation)		r = 0.08, p = 0.24	
Hypertension Status (Chi-square test)	4.71±3.3		$\chi^2 = 2.932$, df = 1, p = 0.087
Obesity (BMI ≥ 25 kg/m²) (Chi-square test)			$\chi^2 = 0.046$, df = 1, p = 0.831
Diabetes Quality of Life (DQoL) (Spearman correlation)		r = 0.197, p = 0.003	

A linear regression analysis was conducted to determine if PSQI scores predict DQoL while adjusting for confounders such as age, gender, presence of hypertension, BMI, income and diabetes duration. The results showed that the regression model was statistically significant ($F(1, 198) = 2.109$, $p = 0.044$), indicating that PSQI significantly predicts DQoL. For each 1-unit increase in PSQI score (indicating worse sleep quality), DQoL increased by 0.255 units ($B = 0.255$, $p = 0.005$), suggesting that poorer sleep quality is associated with worse quality of life in diabetic patients. None of the other factors predicted DQoL.

Discussion

This study evaluated the association between sleep quality and various metabolic factors, including glycemic control, obesity, hypertension, and diabetes-related quality of life (DQoL). Although we didn't find a significant associations between sleep quality and obesity, we did observe a significant relationship between poorer sleep quality and worse quality of life in patients with diabetes. When adjusted for confounders, sleep quality was also found to be significantly associated with glycemic control and hypertension.

Sleep Quality and Glycemic Control: Our findings suggest that poor sleep quality may be associated with poorer glycemic control, but this relationship was not statistically significant in univariate analysis. Similar studies have shown inconsistent results regarding sleep quality and HbA1c levels[12,13]. However, linear regression analysis showed that PSQI was a significantly associated with HbA1c when adjusted for confounders such as age, BMI, gender and diabetes duration. Similar findings have been shown in previous studies. For example, a study by Haack et al. (2007) demonstrated that sleep deprivation led to impaired insulin sensitivity, which could affect long-term glucose control[20]. Conversely, a meta-analysis concluded that both short and long sleep durations were linked to higher HbA1c, suggesting a U-shaped relationship[14].

Sleep Quality and Obesity
It is well-known that obesity increases the risk of developing of type 2 diabetes, and there has been significant interest in the potential relationship between sleep duration, sleep quality, and obesity. Our results revealed no significant association between sleep duration or sleep quality (PSQI) and body mass index (BMI), although a small positive correlation was observed between PSQI scores and BMI. Other studies have reported mixed findings, with some suggesting that poor sleep is associated with increased appetite and weight gain, possibly due to disruptions in hormones such as leptin and ghrelin, which regulate hunger and satiety[21]. A study by Patel et al. (2008) suggested that insufficient or poor-quality sleep may contribute to weight gain and increased adiposity through hormonal imbalances and metabolic dysregulation[22]. However, the absence of a strong relationship in our study could reflect the complex, multifactorial nature of obesity, where factors like diet, physical activity, and genetics may overshadow the effect of sleep quality alone.

Sleep Quality and Hypertension
In our study, hypertension was prevalent in 70.9% of patients, with 78.8% of these patients achieving good blood pressure control. While there was a higher prevalence of poor sleep quality in hypertensive individuals, this association did not reach statistical significance. However, when logistic regression was performed PSQI was significantly associated with an increased likelihood of hypertension.

This result aligns with studies that have found associations between poor sleep and hypertension, yet the effect sizes vary. For instance, a study by Gangwisch et al. (2010) found that short sleep duration was associated with increased risk of hypertension, possibly through sympathetic nervous system activation and inflammatory pathways[23].

Sleep Quality and Diabetes Quality of Life (DQoL)
One of the key findings in this study was the significant positive correlation between poorer sleep quality (higher PSQI scores) and poorer diabetes-related quality of life (higher DQoL scores). This suggests that patients with worse sleep quality experience a worse quality of life, which is consistent with findings from other studies. For example, a study by Suh et al. (2015) reported that poor sleep was associated with higher diabetes-related distress and a reduced sense of well-being[24]. Sleep disturbances can negatively impact emotional and physical health, which may contribute to a lower overall quality of life. Interestingly, we also found a statistically significant negative correlation between sleep duration and DQoL, indicating that longer sleep was associated with better quality of life. This finding warrants further investigation, as it may reflect the positive effects of adequate sleep on mood and daily functioning.

Limitations

We need to consider several limitations in this study when interpreting the results. First, cross-sectional studies cannot establish causal relationship between sleep quality and metabolic factors. Longitudinal studies would be valuable to better understand the directionality of these associations. Second, the reliance on self-reported data for sleep quality could introduce recall bias, although the PSQI is a validated instrument widely used in sleep research. Third, while we controlled for various confounders, unmeasured variables, such as physical activity levels, diet, and medication adherence, may have influenced the outcomes. Finally, the study sample was predominantly from the Western province of Sri Lanka, and results may not be generalizable to other regions with different socioeconomic or cultural factors.

Conclusion

In conclusion, this study found no significant associations between sleep quality and obesity, but it did identify a significant relationship between poorer sleep quality and poorer diabetes-related quality of life. When adjusted for confounders, glycaemic control and hypertension was significantly associated with sleep quality. These findings suggest that improving sleep quality may enhance quality of life for patients with diabetes and could possibly help to improve glycaemic control and management of other metabolic factors. Further research, particularly longitudinal studies, are needed to explore the complex relationships between sleep and diabetes outcomes. Interventions aimed at improving sleep quality may prove beneficial in improving the overall well-being of individuals with diabetes, especially in the context of managing comorbidities and enhancing quality of life.

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