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How sleep quality is associated with blood glucose levels in elderly diabetics melitus: A critical study at Cukir Community Health Center

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Abstract. This research aims to analyze the relationship between sleep quality and blood glucose levels in elderly patients with diabetes mellitus at Puskesmas Cukir, Jombang. Diabetes mellitus (DM) is a common chronic disease among the elderly, and poor sleep quality has been identified as a factor that may worsen diabetes management. This study is important as it addresses the gap in understanding how sleep quality directly impacts diabetes control, particularly in elderly individuals, where both sleep disturbances and diabetes are prevalent. Previous research has typically studied sleep quality or diabetes management separately, with few examining their interrelationship in elderly diabetic patients. The study used a quantitative approach with a cross-sectional design, involving 80 diabetic patients aged 50-60 years. Data was collected using the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality, while blood glucose levels were measured concurrently. The results revealed that 68% of respondents had poor sleep quality, and 49% had uncontrolled blood glucose levels. Statistical analysis using Spearman's correlation test showed a significant relationship between sleep quality and blood glucose levels ($r = 0.823$, $p = 0.016$), indicating that poor sleep quality is linked to higher blood glucose levels. This study concludes that poor sleep quality negatively affects blood glucose control in elderly patients with diabetes. The findings suggest that improving sleep quality could be an essential intervention for better glucose control and preventing diabetes-related complications. Healthcare professionals should consider sleep quality in diabetes management and provide interventions to improve sleep hygiene in elderly diabetic patients.

Keywords: Sleep quality, Blood glucose, Diabetes mellitus, Elderly

Introduction

Aging is the final phase in a person's life. Aging causes changes in body functions that gradually decline over time. The aged are more at risk of disease due to a weakened immune system. The elderly have a large number of non-communicable diseases (NCDs) including hypertension, rheumatism, stroke, chronic obstructive pulmonary disease (COPD), cancer, coronary heart disease, heart failure, kidney failure, kidney stones, and diabetes mellitus (Harianto et al., 2021).

Diabetes Mellitus (DM) is a chronic Non-Communicable Disease (NCD) with high morbidity and mortality rates. It occurs due to the body's inability to produce or ineffective function of the insulin hormone (Tajiwalar et al., 2023). Normally, the hormone insulin is secreted by the pancreas to stabilize blood Glucose levels in the body. However, in people with DM, the hormone cannot be secreted and results in uncontrolled Glucose levels in the body. High blood Glucose levels significantly impact the sleep quality of DM patients due to the high frequency of urination at night. Various sleep disorders are linked to high blood glucose levels and poor glycemic control, suggesting that insufficient sleep may exacerbate glucose intolerance, thereby increasing the risk of developing diabetes mellitus (Addo et al., 2024). Moreover, poor sleep quality has been shown to interfere with glucose metabolism—research highlighting the impact of sleep on glycemic control has noted that sleep disruptions can negatively affect insulin production and utilization, leading to elevated fasting blood glucose levels (Qamar et al., 2023). The bidirectional relationship between sleep quality and diabetes has been emphasized in several studies. Poor sleep not only contributes to the development of DM but is also a significant consequence of poorly managed diabetes. For instance, Mete and Keskin (2023) explain how sleep deprivation induces metabolic changes that decrease glucose tolerance while also increasing cortisol levels, a stress hormone associated with elevated blood sugar (Mete & Keskin, 2023). This complex interplay creates a troubling feedback loop, where poor sleep exacerbates diabetes management issues, ultimately leading to heightened hyperglycemia.

Sleep quality refers to a person's ability to maintain a state of sleep and achieve both Rapid Eye Movement (REM) and Non Rapid Eye Movement (NREM) stages. Good sleep is needed to form new body cells, repair damaged body cells, give organs time to rest and maintain metabolic and biochemical balance in the body (Harianto et al., 2021). Poor sleep quality can lead to metabolic and cardiovascular diseases (Padhi et al., 2020). Research has shown that better sleep can improve glycemic control and quality of life in type 2 diabetes patients, suggesting that poor sleep negatively impacts diabetes management (Lee & Kim, 2022). Additionally, Pan et al. (2023) emphasize that sleep disturbances and short sleep duration can worsen various health issues, including diabetes mellitus (Pan et al., 2023). Sleep quality also plays a crucial role in recovery and healing processes. Poor sleep has been shown to increase inflammation and stress responses, adversely affecting recovery from various health conditions, including diabetes (Lee & Kim, 2022). This research has significant implications for therapeutic strategies, as consistent and restorative sleep is crucial for effective diabetes management and can significantly enhance the healing processes related to the disease. Furthermore, Wang et al. (2022) highlight the complex relationship between sleep deprivation and cardiovascular health, indicating that prolonged lack of sleep can lead to long-term cardiovascular changes, further endangering individuals with diabetes, who are already at higher risk for heart complications (Wang et al., 2022). This interaction underscores the importance of addressing sleep quality in comprehensive diabetes care management.

The number of people with Diabetes Mellitus in Indonesia in the adult population (age range 20-79 years) reached 19,465,100 people with a prevalence of 10.6%. This is very alarming, proven in the last 10 years it has increased twice, which initially in 2011 only amounted to 7.3 million people. Not only that, the number of Internasional Diabetes Federation (IDF) predictions in 2045 for DM sufferers in Indonesia is around 28.6 million

people (IDF, 2021). Then, the number of people with DM in East Java Province reached 929,810 people, which increased from the previous year of 875,745 people and is still in the top 10 (Kementerian Kesehatan Jawa Timur, 2021) After that, the number of people with DM in Jombang Regency reached 34,924 people, which increased from the previous year by 34,261 people. The largest number of people with DM in Jombang Regency who were recorded referred to the Cukir Health Center, namely 1,705 people, followed by the Perak and Bareng Health Centers with 1,513 and 1,512 people (Jombang Health Office, 2023).

In patients with Diabetes Mellitus, decreased glucose uptake into muscle and adipose tissue leads to accumulation of glucose in the blood (hyperglycemia >100 mg/100 ml plasma). When blood Glucose levels exceed 160-180 mg/dl, the kidneys excrete glucose into the urine (glycosuria), triggering osmotic diuresis and polyuria. This condition forces the kidneys to produce excess urine to dilute glucose, causing frequent urination, especially at night, which disrupts sleep patterns (Firdaus et al., 2022). Sleep disturbances in DM patients are influenced by three factors: physical (nocturia, excessive thirst, skin itching, neuropathy, body discomfort), psychosocial (stress, anxiety, depression-90% of insomnia-related cases), and environmental (noise, poor ventilation, suboptimal lighting/temperature, unpleasant odors).

Poor sleep quality activates the neuroendocrine system, increasing cortisol through gluconeogenesis which triggers glucose production. Sleeping less than 7 hours increases ghrelin (appetite regulator) and decreases leptin, leading to insulin resistance and impaired glucose tolerance, while decreased growth hormone (GH) exacerbates metabolic dysregulation. These hormonal changes worsen glycemic control (Istigfarin et al., 2020). This study aims to identify the correlation between sleep quality and blood Glucose levels in patients with DM at the Cukir Health Center. Specifically, this study aims to describe the profile of the quality of sleep of elderly people with DM, measure their blood Glucose levels, and analyze the relationship between the two. The results of the study are expected to provide empirical evidence of the impact of sleep disturbances on glycemic control, so that it can be a recommendation for actions that can be pursued in controlling the quality of sleep of patients with DM to provide better results for patient health.

Methods

This study employs a cross-sectional quantitative approach to analyze the association between sleep quality and blood glucose levels, in which data are collected, measured, and analyzed simultaneously without intervention on the subject to answer research questions and test hypotheses. This research design serves as a strategy and guideline in achieving the stated research objectives. This study will test 80 samples of patients aged 50-60 years who have Diabetes Mellitus. Data collection using the Pittsburgh Sleep Quality Index (PSQI) questionnaire. This study will use sleep quality as the independent variable, and blood Glucose levels as the dependent variable. The results of these two tests will be statistically analyzed using the Spearman Test to obtain the conclusion of the research results. This research was conducted at the Cukir Health Center, Jombang Regency, located on Jl. Raya Mojowarno No.9, Cukir, Kec. Diwek,

Jombang Regency, East Java with the research time starting from April 14, 2024 to April 16, 2024 at the Cukir Health Center, Jombang Regency, the following data were obtained. The limited duration of the study, conducted over 3 days, was due to time constraints and the prioritization of activities at Puskesmas Cukir, Jombang, as well as the need to gather preliminary data for further analysis. This research aims to provide an initial overview of the relationship between sleep quality and blood glucose levels in elderly patients with diabetes mellitus at Puskesmas Cukir. Although the short duration of the study may limit the depth of the data collected, the chosen timeframe was based on the urgency to promptly identify factors influencing diabetes control and sleep quality in the elderly population, allowing for the implementation of earlier interventions.

Despite its limitations, the study provides relevant data that can serve as a foundation for future research involving a larger sample size and a longer period of observation. In terms of data reliability, while the short duration affects the scope of the observations, the findings remain representative in assessing the initial relationship between sleep quality and blood glucose levels at Puskesmas Cukir. With extended time and a broader sample in future research, it is hoped that more comprehensive and in-depth findings can be obtained.

The inclusion criteria used in this study aim to ensure that the respondents involved have characteristics that align with the research objectives and can provide valid data. Diabetic patients who meet the inclusion criteria are those who are willing to participate as respondents, cooperative, and have signed an informed consent form as consent to participate in this study. Respondents must also be able to read and write to understand and complete the provided questionnaire. A specific age range is used to include the "Adult (40-50)", "Early Elderly (50-60)", "Late Elderly (61-75)", and "Seniors (>75 years)" groups to ensure that the sample used is relevant to the study's objectives, which focuses on diabetic patients in vulnerable age groups. This age range is expected to provide a representative picture of how sleep quality and blood glucose control affect different elderly age groups, which is the primary focus of this research.

Exclusion criteria are established to avoid factors that may affect the accuracy of the research results. Diabetic patients who are absent during the study or who have specific medical conditions that prevent them from participating, such as complications requiring complete bed rest, are excluded from the study sample. Additionally, respondents who do not follow the procedure for completing the questionnaire or provide incomplete responses are also excluded from the analysis, as this could compromise the validity and reliability of the obtained data. By applying these inclusion and exclusion criteria, this study ensures that the selected sample can represent the relevant population and provide reliable data for analyzing the relationship between sleep quality and blood glucose levels in elderly patients with diabetes mellitus. The following framework in this study as a procedural stage of the research is presented in Figure 1.

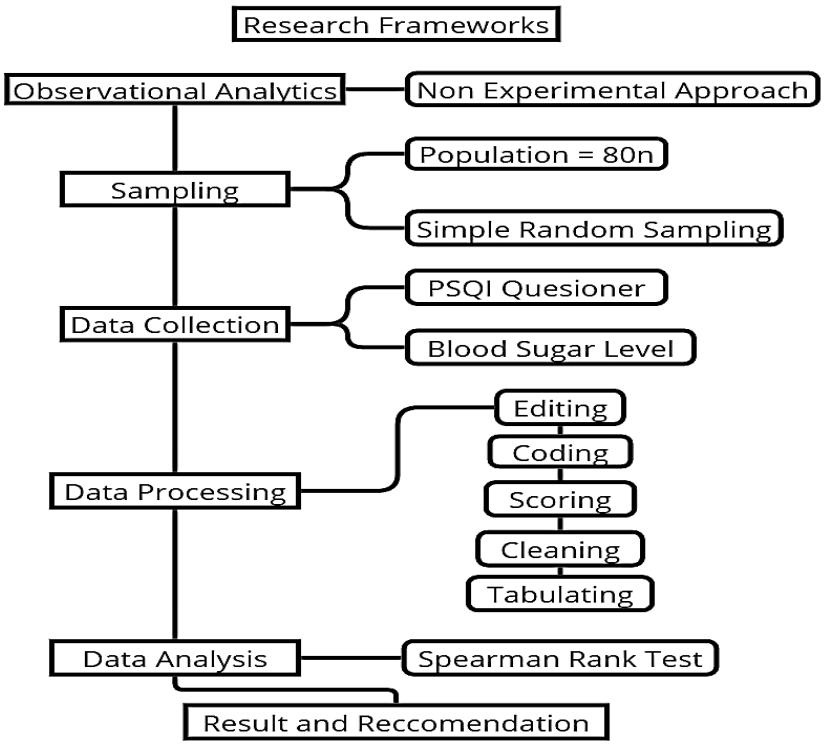

Figure 1. Research Framework
Source: Author, 2025

Result and Discussion

Characterization of Observed Sample

This research was conducted at the Cukir Health Center, Jombang Regency, located on Jl. Raya Mojowarno No.9, Cukir, Kec. Diwek, Jombang Regency, East Java. Based on research conducted on April 14, 2024 until April 16, 2024 at the Cukir Health Center, Jombang Regency, the following data were obtained.

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Table 1 Frequency Tabulation of Respondents by Age

No	Ages	Frequency	Percentage %
1	Adult	9	11%
2	Early Elderly	15	19%
3	Late Elderly	29	36%
4	Seniors	27	34%
Total		80	100%

Source: Research Data, 2024

Table 1 shows that the majority of respondents in this study came from the elderly age group, with the Late Elderly category as the largest group (29 respondents or 36%).

The elderly followed with almost the same number, 27 respondents (34%). Meanwhile, the Early Elderly included 15 respondents (19%), and the Adult group was the least numerous category, with only 9 respondents (11%). This distribution shows that the study involved more individuals from the elderly age group than adults.

Table 2 Frequency Tabulation of Respondents Based on Gender

No	Gender	Frequency	Percentage %
1	Male	49	61%
2	Female	31	39%
Total		80	100%

Source: Research Data, 2024

The gender distribution of respondents in Table 2 shows that the majority of study participants were male, with 49 respondents (61%). Meanwhile, women amounted to 31 respondents (39%), which means that the proportion is smaller than that of men. This difference shows that the research was dominated by male participation, although the female group still had a significant representation.

Table 3 Frequency Tabulation of Respondents Based on Occupation

No	Occupations	Frequency	Percentage %
1	Private Employee	10	13%
2	Self-employed	18	23%
3	Farmer	13	16%
4	Civil Servant	1	1%
5	Housewife	36	45%
6	Retired	2	2%
Total		80	100%

Source: Research Data, 2024

The occupational distribution of respondents in Table 3 shows that the majority of study participants were housewives, with 36 respondents (45%), almost half of the total sample. Self-employed became the second largest group with 18 respondents (23%), followed by Farmers with 13 respondents (16%). Private Employees accounted for 10 respondents (13%), while the Retired and Civil Servants groups had the least number, 2 respondents (2%) and 1 respondent (1%) respectively. This data shows that respondents come from various occupational backgrounds, with the dominance of housewives and self-employed people.

Table 4 Frequency Tabulation of Respondents Based on Duration of DM Suffering

No	Long Suffering (year)	Frequency	Percentage %
1	1-3	21	26%
2	4-6	19	24%
3	7-10	27	34%
4	>10	13	16%
Total		80	100%

Source: Research Data, 2024

The distribution of duration of diabetes mellitus based on Table 4 shows that the majority of respondents have lived with this condition for a long time. The largest group is those who have suffered for 7-10 years as many as 27 respondents (34%). Followed by

the 1-3 years group with 21 respondents (26%), and 4-6 years with 19 respondents (24%). Meanwhile, respondents who have suffered from diabetes for more than 10 years amounted to 13 people (16%), being the group with the least number. This data reflects that most respondents have experienced diabetes in the Moderate to long term.

Table 5 Frequency Tabulation of Respondents Based on Duration of DM Suffering

No	Sleeping Quality	Frequency	Percentage %
1	Good	26	32%
2	Bad	54	68%
Total		80	100%

Source: Research Data, 2024

The distribution of respondents' sleep quality in Table 5 shows that the majority experienced poor sleep quality, with 54 respondents (68%) falling into this category. Meanwhile, only 26 respondents (32%) had good sleep quality. This data indicates that most of the respondents faced disturbed or decreased sleep quality, which could potentially affect their health condition, especially in relation to diabetes mellitus.

Table 6 Frequency Tabulation of Respondents Based on Timed Blood Glucose Level (BGL)

No	Sleeping Quality	Frequency	Percentage %
1	Good	25	28%
2	Moderate	18	23%
3	Bad	37	49%
Total		80	100%

Source: Research Data, 2024

The distribution of BGL levels in Table 6 shows that almost half of the respondents had BGL levels in the Poor category, namely 37 respondents (49%). Meanwhile, 25 respondents (28%) had Good BGL levels, and 18 respondents (23%) were in the Moderate category. This data indicates that most respondents have poorly controlled BGL levels, which have the potential to increase the risk of diabetes complications if not managed properly.

Table 7 Frequency Tabulation of Respondents Based on Timed Blood Glucose Level (BGL)

Kualitas Tidur	Kadar BGL			Total
	Good	Moderate	Bad	
Good	19	6	1	26
	(73%)	(23%)	(4%)	(100%)
Bad	6	12	36	54
	(11%)	(22%)	(67%)	(100%)
Total	25	18	37	80
	(28%)	(23%)	(49%)	(100%)

Source: Research Data, 2024

Based on table 7, data obtained from respondents with poor sleep quality and poor BGL levels were 36 respondents (67%), respondents with poor sleep quality and good BGL levels were 1 respondent (4%). while respondents with good sleep quality and poor BGL levels were 6 respondents (11%), respondents with good sleep quality and good BGL levels were 19 respondents (73%).

Statistical Result of Data

Reability Test

Table 8. Correlations Test Result of Sleep Quality and Blood Glucose Level (BGL)

Correlations

			Sleep Quality	BGL
Spearman's rho	Sleep Quality	Correlation Coefficient	1,000	,823**
		Sig. (2-tailed)		0,016
		N	80	80
	BGL	Correlation Coefficient	,823**	1,000
		Sig. (2-tailed)	0,016	
		N	80	80

**. Correlation is significant at the 0.05 level (2-tailed).

Source: Result Analysis, 2024

Table 9. Reability Test Result of Sleep Quality and Blood Glucose Level (BGL)

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		80
Normal Parameters[a,b]	Mean	,0000000
	Std. Deviation	,82616759
Most Extreme Differences	Absolute	,224
	Positive	,224
	Negative	-,212
Test Statistic		,224
Asymp. Sig. (2-tailed)		,200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

Source: Result Analysis, 2024

The results of the analysis show that the test performed is non-parametric because both variables are included in the ordinal data scale. The value of Asymp. Sig. (2-tailed) is 0.200, which is greater than the alpha value (0.005), so it can be concluded that the data is normally distributed. In addition, the P (Sigma) value is 0.016, which indicates that the p value < alpha value (0.05). Thus, H1 is accepted and H0 is rejected, which means that there is a significant relationship between sleep quality and current blood sugar levels in elderly people with diabetes mellitus at BLUD Puskesmas Cukir..

The Correlation Analysis of Diabetes Mellitus and Sleep Quality

Sleep Quality in Elderly Diabetes Patients

The results on based table 7 of this study obtained 54 respondents (68%) had poor sleep quality and 26 respondents (32%) had good sleep quality. This shows that the quality of sleep of DM patients at the Cukir Health Center, Jombang Regency, is mostly poor. Poor sleep quality in the elderly can be caused by various factors, including physiological changes that occur with age, such as decreased production of the hormone melatonin and disturbances in the sleep cycle (Utami et al., 2021). Research shows that poor sleep quality is associated with an increased risk of chronic diseases, including diabetes mellitus, which can worsen the quality of life of the elderly (Farida et al., 2021). Poor sleep quality in respondents can be related to several factors, including inadequate sleep duration and the presence of sleep disorders. Based on research by (Jahrami et al., 2021), the ideal sleep duration for humans is around 7 hours per day, but the respondents in this study only got between 5 to 6 hours of sleep, which is clearly less than this need (Jahrami et al., 2021). Other studies have also shown that sleep deprivation can contribute to a decrease in overall sleep quality, potentially increasing the risk of mental and physical health disorders (Harami et al., 2021; Kalamara et al., 2022).

Sleep disturbances experienced by respondents, such as pain, nightmares, and frequent awakenings in the middle of the night, were also significant factors in reducing sleep quality. The C5 questionnaire score, which showed that many respondents recorded scores between 31 to 40, indicated serious sleep disturbances (Kumar & Pandey, 2023) This finding is in line with the study by Winkelman et al., (2018), who noted that the majority of respondents experienced similar sleep disturbances, including nighttime awakenings to urinate and daytime sleepiness, which contributed to their poor assessment of sleep quality (Harami et al., 2021). Other factors that may affect sleep quality include environmental conditions such as uncomfortable temperatures and breathing difficulties, which were also reported by respondents. Research shows that sleep-disordered breathing can lead to nighttime awakenings and reduce overall sleep quality (Kapur et al., 2017). In addition, psychological conditions such as anxiety and stress also play a role in worsening sleep quality, which is often compounded by external factors such as workload and social pressure (Sériès et al., 2025; Thadathil et al., 2024).

Thus, from the factual findings and theoretical explanations above, the lack of adequate sleep duration and the presence of significant sleep disturbances, such as pain and waking up in the middle of the night, are the main causes of poor sleep quality in respondents.

Blood Glucose Levels in Elderly Diabetes Patients

The results on based table 7 of this study obtained data as many as 37 respondents (49%) showed poor BGL levels, 18 (23%) respondents with moderate BGL levels, and 25 respondents (28%) with good BGL levels. This shows that the BGL levels of DM patients at the Cukir Health Center, Jombang Regency are mostly poor. High blood sugar levels can be caused by various factors, including an unhealthy diet, lack of physical activity, and psychological stress. Research shows that poor management of diabetes can lead to serious complications, including sleep disturbances and decreased quality of life (Safitri et al., 2022). High blood glucose levels (BGL) in patients with diabetes mellitus (DM) are caused by several factors, including abnormal insulin production and impaired

insulin utilization, or a combination of both. According to Santoso et al. (2018), this condition occurs when the body is unable to produce enough insulin to convert glucose into glycogen, causing glucose levels to remain high in the body (Camili et al., 2024). This is reinforced by the research of Umam et al. (2020), which showed that damage to the pancreas, which is responsible for insulin production, as well as gene mutations affecting pancreatic beta cells, contribute to the body's inability to regularly produce insulin as needed (Camili et al., 2023).

Diabetes mellitus can also be caused by hormonal syndromes such as Cushing's syndrome and acromegaly, which can impair insulin secretion and function (Mahmoud et al., 2023). The body's inability to produce sufficient insulin is often due to a lack of beta cells or peripheral insulin resistance, where insulin receptors are damaged, reducing the effectiveness of insulin in delivering biochemical signals to the body's cells (Sun, 2024). In type 2 diabetes, when oral medications fail to stimulate adequate insulin release, injections become a commonly used alternative (McGlone et al., 2021). Poor sleep quality also contributes to metabolic disorders, including glucose processing. Research from the University of Chicago shows that sleep deprivation can significantly decrease the body's ability to process glucose, which increases the risk of diabetes (Fabbri et al., 2021). In addition, sleep deprivation can stimulate certain hormones in the blood that increase appetite, encouraging individuals to consume high-calorie foods, which in turn can increase blood sugar levels (Zhang et al., 2023). This suggests that good sleep quality is crucial in the management of diabetes and overall metabolic health.

Based on the factual and theoretical findings, we conclude that high BGL values are most likely related to inadequate sleep duration. This condition generally arises because individuals often wake up during the night to urinate, thus having difficulty falling back asleep and resulting in a short total sleep time. This lack of sleep time can reduce cell sensitivity to insulin, which in turn has the potential to significantly increase blood glucose levels (hyperglycemia).

Relationship Between Sleep Quality and Blood Glucose Levels in Elderly Diabetes Patients

Based on table 7, data obtained from respondents with poor sleep quality and poor BGL levels were 36 respondents (67%), respondents with poor sleep quality and good BGL levels were 1 respondent (4%). while respondents with good sleep quality and poor BGL levels were 6 respondents (11%), respondents with good sleep quality and good BGL levels were 19 respondents (73%). This shows that sleep quality is significantly associated with to temporary blood sugar, the worse the quality of sleep, the worse the BGL levels. The statistical test analysis shows that the results of the spearman rank test r = 0.016 with a p-value of 0.000 <0.05 so that there is a significant correlation between sleep quality and BGL levels of the elderly at the Cukir Health Center, Jombang Regency. This shows that there is a relationship between sleep quality and temporary blood sugar. The worse the quality of sleep, the worse the elderly BGL levels, and vice versa.

Research shows that poor sleep quality can affect glucose metabolism and insulin sensitivity, which in turn can lead to elevated blood sugar levels (Ludiana et al., 2022; Safitri et al., 2022). In addition, high blood sugar levels can also lead to sleep disturbances, creating a cycle that is detrimental to health (Rosyidah et al., 2023; Aprilani & Warsono, 2023). Research showing the relationship between sleep duration and blood

glucose control is increasingly found in the scientific literature. Yi et al. (2023) in their study revealed that sleep deprivation can reduce insulin sensitivity and impair glucose tolerance in individuals with type 2 diabetes (Yi et al., 2023). This study confirmed that short sleep duration contributes significantly to impaired glucose metabolism. This is in line with the findings of (Hannon et al., 2021), who emphasized that short sleep duration is closely associated with decreased insulin sensitivity, which is an important risk factor for type 2 diabetes (Hannon et al., 2021). Furthermore, experimental research by Promsod et al. (2023) showed that sleep restriction can rapidly reduce glucose tolerance and insulin sensitivity in healthy individuals (Zhang et al., 2022). This study provides additional evidence regarding the negative impact of sleep deprivation on glucose metabolism. Lin et al. (2021) also highlighted the importance of sleep duration and circadian rhythm in regulating insulin production and insulin sensitivity, indicating that sleep deprivation can impair pancreatic beta cell function and lead to elevated blood glucose levels (Promsod et al., 2023).

In this context, a recent study by Yi et al. (2023) suggests that insulin regulatory mechanisms related to sleep duration may be affected by changes in sleep architecture and melatonin secretion, which contribute to systemic inflammation (Yi et al., 2023). In addition, Hannon et al. (2021) provided mechanistic evidence linking insufficient sleep to reduced insulin sensitivity, as measured through an intravenous glucose tolerance test (Hannon et al., 2021). This research confirms that sleep disturbances can significantly affect glucose metabolism. Research by Elshoeibi et al. (2023) showed that individuals with short sleep duration have a higher risk of developing diabetes mellitus, while long sleep duration may increase the risk (Lin et al., 2021). These findings are consistent with the results of a study by (He et al., 2022), which stated that short sleep duration contributes to insulin resistance, which is a major factor in the development of metabolic syndrome (Zou et al., 2021). Thus, it can be concluded that inadequate sleep duration has a significant impact on blood glucose control and insulin sensitivity, potentially increasing the risk of type 2 diabetes.

Based on the questionnaires filled out, it was found that the average respondent only got about 5-6 hours of sleep per night. This lack of sleep duration, plus partial sleep disruption lasting 14 nights, has the potential to decrease insulin sensitivity and reduce the body's tolerance to glucose. According to Jahrami et al. (2021), the optimal sleep time should be around 7 hours per day. However, in this study, the respondents only got between 5 to 6 hours of sleep, which is clearly below the recommended standard. In addition, other studies have indicated that sleep deprivation can significantly reduce overall sleep quality, thereby increasing the likelihood of mental and physical health disorders (Kalamara et al., 2022; Harami et al., 2021).

Based on the findings of the facts and theories that have been presented, we conclude that inadequate sleep quality - characterized by short sleep duration of about 5 hours per day and high sleep latency in the elderly with DM - can reduce glucose tolerance and insulin sensitivity. As a result, this could potentially lead to increased blood glucose levels that are difficult to control.

Confounding Factors

Firstly, lifestyle choices, such as diet and physical activity, serve as critical confounders in understanding the relationship between sleep quality and blood glucose

control. The role of dietary habits, particularly the consumption of high-calorie foods and their impact on glucose regulation, is well-established in the literature. For instance, Bitencourt et al. (2024) emphasized that lifestyle factors, including dietary choices, can significantly increase the likelihood of diabetes complications. Furthermore, the link between physical inactivity and diabetes management suggests that individuals with a sedentary lifestyle often struggle to control their blood glucose levels effectively (Bitencourt et al., 2023). Therefore, poor dietary habits and a lack of physical activity can indirectly influence both sleep quality and glucose metabolism, exacerbating the challenges faced by diabetes patients.

Socioeconomic factors also play a pivotal role in shaping health outcomes. Financial constraints often affect individuals' ability to access healthcare services, medications, and even healthy food choices, leading to an increased risk of inadequate diabetes management. Studies have shown that individuals with lower incomes are more likely to encounter difficulties in managing chronic diseases like diabetes, which can lead to additional complications such as poor sleep quality and uncontrolled blood glucose levels (Hu et al., 2024). Research further underscores the association between diabetes and lower socioeconomic status, where financial limitations may force individuals to neglect health-promoting practices (Warrick et al., 2024).

Psychological conditions, such as stress, anxiety, and depression, act as additional confounding factors that can amplify the impact of diabetes on health. Emotional distress in diabetic patients has been linked to both sleep disturbances and elevated blood glucose levels, creating a vicious cycle that worsens patient outcomes (Ren et al., 2024). As Ren et al. (2024) explain, the physiological and hormonal disruptions caused by depression can significantly influence metabolic control, complicating diabetes management. Moreover, Hussain et al. (2024) point out that psychological burdens are often underrecognized in diabetes treatment plans, suggesting that these factors should be given more attention in future research.

Lastly, access to healthcare services is another confounding factor that can distort the relationship between sleep quality and blood glucose control. Disparities in healthcare access can result in inconsistent monitoring and management of diabetes, which in turn affects both sleep quality and glucose regulation (Wu et al., 2024). Wu et al. (2024) highlight that inadequate healthcare services often lead to uncontrolled diabetes, which can worsen complications. Taken together, the evidence reveals a strong interplay between these confounding factors and health outcomes in diabetes patients, indicating that thorough research must control for these variables to ensure accurate conclusions.

Conclusion

The results of this study indicate that most elderly people with diabetes mellitus at the Cukir Health Center in Jombang Regency experience inadequate sleep quality. In addition, the majority of respondents had suboptimal blood sugar levels (BGL). Data analysis also revealed a significant relationship between sleep quality and BGL levels in elderly people with diabetes mellitus, indicating that sleep disturbances can affect blood sugar control in this group.

Based on these findings, healthcare workers are expected to be more meticulous in monitoring the sleep quality of patients with diabetes mellitus by conducting routine screening and providing education on the importance of quality sleep. Patients are also advised to maintain healthy sleep patterns and regularly check their blood glucose levels for more effective monitoring. Furthermore, further research should be conducted with a larger sample and more diverse locations to better understand the factors influencing blood glucose levels in diabetes patients, providing more comprehensive insights for efforts to prevent and treat this disease. Future research should explore the long-term effects of improving sleep quality on blood glucose management in diabetes patients. It should also examine the impact of other factors, such as psychological well-being, medication adherence, and lifestyle changes, on sleep control and glucose levels. Additionally, future studies could develop various interventions to improve sleep quality, such as cognitive behavioral therapy for insomnia or other sleep-enhancing treatments, and assess their impact on diabetes management.

However, this study has some limitations. The small sample size and short duration of data collection may not fully capture the variations in sleep quality and blood glucose levels across different seasons or over longer periods. Further research with longitudinal studies and larger, more diverse populations is necessary to confirm these findings and explore the underlying mechanisms in more depth. Patients are also advised to maintain healthy sleep patterns and regularly check blood glucose levels for more effective monitoring. In addition, further research needs to be conducted with a wider range of samples and locations to understand more deeply the factors that affect blood glucose levels in patients with diabetes mellitus, so as to provide more comprehensive insights for efforts to prevent and treat this disease.

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