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Review Paper

The Sleep-Diabetes Connection: Adherence Insights

Khulood Qureshi*, Rohit Bhosle, Shivani Rathod, Aachal Mulgir, Vidya Kapse

Department of Pharmacy Practice, Shivlingeshwar College of Pharmacy, Latur, Maharashtra.

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ABSTRACT

Type 2 diabetes mellitus (T2DM) is a major global health issue, affecting 537 million adults in 2021, with numbers expected to hit 783 million by 2045. Poor sleep quality is a key, often overlooked factor in T2DM development and progression. This study examines the prevalence of sleep disorders in T2D patients, bidirectional links with glycemic control, impact on quality of life, and risk factors like obesity and comorbidities. It shows up to a third of diabetes patients have sleep disorders, compared to 8.2% of non-diabetics. Over half of T2D patients report poor sleep, linked to Stop-Bang Questionnaire, increased insulin resistance, and poor glycemic control. Poor sleep correlates with higher HbA1c levels, impacting self-management, mental health, and quality of life. Mechanisms linking sleep and T2DM include disrupted insulin sensitivity, circadian rhythms, and hormonal regulation. Sleep deprivation induces insulin resistance, increases lipolysis, and elevates fatty acid levels. Risk factors for sleep disturbances in T2D include obesity, diabetes duration, and comorbidities like cardiovascular disease and depression. Targeted interventions addressing sleep disorders can mitigate these issues and enhance diabetes management. Understanding sleep disorders in T2D patients is crucial for improving health outcomes and quality of life.

INTRODUCTION

Diabetes mellitus is a highly prevalent disorder that is closely linked to rapid social and cultural transitions, including population aging, urbanization, shifts in dietary patterns, decreased physical activity, and unhealthy lifestyle behaviors. These factors contribute to a reduced quality of life and lower life expectancy among

affected individuals[1]. Sleep disorders and other sleep-related problems affect a large proportion of the population. Reduced sleep duration is often attributed to the stress and demands of modern life. Type 2 diabetes mellitus (T2DM) is a common chronic metabolic disorder characterized primarily by hyperglycemia and insulin resistance. Over the past few decades, the global prevalence of type 2 diabetes has increased significantly. The main

***Corresponding Author:** Khulood Qureshi

Address: Department of Pharmacy Practice, Shivlingeshwar College of Pharmacy, Latur, Maharashtra.

Email ✉: khuloodqurashi@gmail.com

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objective of this study was to examine the relationship between sleep and type 2 diabetes. Type 2 diabetes is characterized by elevated blood glucose levels and insulin resistance, making it one of the most prevalent chronic metabolic diseases worldwide. Although genetic predisposition and lifestyle factors such as diet and physical inactivity play major roles in its development, recent evidence suggests a strong correlation between sleep quality and the risk of developing type 2 diabetes.

LITERATURE REVIEW:

Sleep and Its Phases

Sleep is a complex physiological process consisting of two primary phases: rapid eye movement (REM) sleep and non-rapid eye movement (NREM) sleep. NREM sleep is further divided into three stages, with stage three representing the deepest and most restorative phase. Throughout the night, individuals cycle through these stages repeatedly, with each cycle lasting approximately 90 minutes.

Role of Sleep in Glucose Regulation

Insulin Sensitivity

One of the primary mechanisms linking sleep and type 2 diabetes involves insulin sensitivity. Insulin, a hormone secreted by the pancreas, facilitates glucose uptake into cells and helps regulate blood sugar levels. Chronic sleep deprivation reduces insulin sensitivity, causing the body's cells to respond less effectively to insulin. This impaired response contributes to elevated blood glucose levels and plays a central role in the development of type 2 diabetes.

Circadian Rhythms

The circadian rhythm, often referred to as the body's internal biological clock, regulates numerous physiological processes, including glucose metabolism. Irregular sleep schedules, such as those associated with shift work, can disrupt circadian rhythms and impair glucose regulation. Such disruptions may increase the risk of insulin resistance and the development of type 2 diabetes.

Hormonal Regulation

Sleep is crucial for maintaining hormonal balance, including hormones directly involved in glucose metabolism. Sleep deprivation can lead to elevated cortisol levels, which may promote insulin resistance and raise blood glucose levels. Additionally, growth hormone and other metabolic-regulating hormones are released during sleep, further highlighting the importance of adequate rest in maintaining metabolic health[2,3].

The global prevalence of diabetes is projected to reach 783 million by 2045. Beyond diet, smoking, and inactivity, sleep patterns have emerged as important metabolic risk factors. Average sleep duration has declined over recent decades, making sleep insufficiency a global health concern. Although some studies show a U-shaped association between sleep duration and type 2 diabetes risk, findings remain inconsistent due to methodological differences and ethnic variations. Obesity, closely linked to both poor sleep and diabetes, may modify this relationship, particularly in Asian populations where metabolic risks occur at lower BMI levels. Further long-term studies are needed to clarify moderating effects of age, sex, and sleep disorders[4]. Type 2 diabetes is highly prevalent, and sleep disorders such as insomnia, obstructive sleep apnea (OSA), and restless legs syndrome (RLS) are common among affected individuals. Poor sleep quality is linked to reduced health-related quality of life, impaired



daily functioning, and increased psychological distress, including fatigue and depression. Evidence suggests that sleep disturbances negatively influence diabetes self-care behaviors, including physical activity, diet, and possibly medication adherence. Excessive daytime sleepiness is more frequent in people with type 2 diabetes and is associated with poorer functional outcomes. Overall, untreated sleep problems may significantly worsen metabolic control, well-being, and diabetes management outcomes[5]. Sleep is vital for overall health and is often impaired in type 2 diabetes, contributing to insulin resistance, obesity, and cardiovascular risk. Evidence shows a bidirectional relationship between poor sleep and diabetes control. Short sleep duration is linked to higher HbA1c and impaired glucose tolerance. Our study assessed sleep quality and HbA1c levels using HPLC[6].

Diabetes is a chronic metabolic disorder characterized by persistent hyperglycemia, which progressively damages both macrovascular and microvascular systems. Over time, this damage may result in serious complications affecting the heart, kidneys, eyes, and nerves. Sleep disturbances are frequently reported among individuals with diabetes and are associated not only with an increased risk of developing the disease but also with poorer clinical outcomes. Poor glycemic control, indicated by elevated glycated hemoglobin (HbA1c) levels or nocturnal glucose variability, has been linked to various sleep-related problems, including abnormal sleep duration, circadian rhythm disruptions, insomnia, and restless legs syndrome. Clinical guidelines from leading organizations strongly emphasize regular monitoring to prevent complications. The American Association of Clinical Endocrinology recommends consistent HbA1c testing and evaluation of diabetes-related complications to improve long-term outcomes. Similarly, the American Diabetes Association advises annual

screening for complications and comorbidities such as chronic kidney disease and retinopathy[7]. Sleep is a fundamental component of overall health and quality of life, particularly in older adults. It influences physical functioning, cognitive performance, and psychological well-being. Poor sleep quality is associated with unhealthy eating habits, irritability, fatigue, and altered physiological responses. Sleep disorders—characterized by reduced duration, low efficiency, fragmentation, and daytime sleepiness—represent a major global public health concern. Age-related physiological changes further compromise sleep structure and quality, leading to drowsiness, depression, pain, reduced functional capacity, and increased frailty. Chronic conditions and the growing use of multiple medications are strongly linked to sleep disturbances, highlighting a bidirectional relationship in which sleep problems both contribute to and result from chronic disease[8,9]. Diabetes patients are more prone to sleep disorders. Factors contributing to insomnia include peripheral neuropathy pain, restless legs syndrome, periodic limb movements, nocturnal blood sugar swings (hypo/hyperglycemia), nocturia, depression. Diabetes increases depression risk, which worsens sleep. Diabetes also affects the CNS, altering neurotransmitters, autonomic functions, and endocrine systems, causing sleep issues[10,11]. Diabetes mellitus, especially Type 2 (T2DM), is a major global health issue, accounting for over 90% of cases. With 537 million adults affected in 2021, numbers are expected to hit 643 million by 2030 and 783 million by 2045. T2DM leads to serious complications like cardiovascular disease, stroke, and kidney damage, impacting mortality and healthcare costs. Risk factors include aging, genetics, inactivity, and poor diet. Recent studies highlight poor sleep quality as a key, often overlooked factor in T2DM development and progression. People with T2DM report worse



sleep quality than the general population, linked to increased insulin resistance and poor glycemic control. Poor sleep is associated with higher HbA1c levels and negatively impacts self-management, mental health, and quality of life. It's also tied to higher cardiovascular risks and mortality in T2DM patients. Identifying and addressing poor sleep is crucial for better disease management and outcomes[12]. Good sleep is crucial for managing chronic conditions like diabetes. Poor sleep quality affects every aspect of life, exacerbating issues like seizures, memory deficits, and headaches, further worsening quality of life. Research shows up to a third of diabetes patients have sleep disorders, compared to 8.2% of non-diabetics. Over half of type 2 diabetes patients report poor sleep, linked to Stop-Bang Questionnaire scores. Poor sleep correlates with insulin resistance, impacting diabetes self-management. Studies link poor sleep to decreased GABA levels, also seen in depression. GABA, produced in the pancreas, inhibits apoptosis of beta cells. Orexins, involved in sleep and energy balance, also impact glucose metabolism. A study on sleep restriction in healthy subjects showed reduced peripheral insulin sensitivity, increased lipolysis, and elevated fatty acid levels, driving insulin resistance in extrahepatic tissues[13].

Sleep disturbances mess with appetite regulation, partly due to an overactive orexin system during sleep deprivation. This, plus sympathetic nervous system overactivity, leads to overeating. Ghrelin (hunger hormone) increases, while leptin (satiety factor) decreases. Studies show sleep deprivation induces insulin resistance i.e VanHelder et increased insulin response to glucose after total sleep deprivation 1-week sleep restriction (4h/night) creates a prediabetic state in healthy subjects, Sleep deprivation raises evening cortisol levels, Chronic sleep deprivation impairs glucose tolerance. In sleep disordered breathing (SDB) like OSA, intermittent hypoxia and sleep

fragmentation increase sympathetic activity, decreasing insulin sensitivity and raising blood glucose[14]. DM affects 529 million worldwide, impacting all age groups. Sleep is crucial for metabolism, hormone regulation, and immune response. Sleep disorders are common in DM, linked to stroke, depression, and reduced quality of life. T2DM, driven by insulin resistance or low secretion, is rising globally, especially in developing countries. Prevalence is expected to jump from 5.9% (2021) to 9.5% (2050). Inadequate sleep quality worsens glycemic control, contributing to T2DM complications like cardiovascular disease, retinopathy, and neuropathy[15].

Understanding sleep disorders in T2D patients is crucial for improving health outcomes and quality of life. This study examines prevalence, bidirectional links with glycemic control, impact on quality of life, and risk factors like obesity and comorbidities. The 66.4% of T2D patients experience sleep disturbances (Hashimoto et al.), poor sleep linked to worse glucose control and vice versa, sleep disorders impair quality of life, daytime functioning, and psychosocial well-being, risk factors include obesity, diabetes duration, and comorbidities like cardiovascular disease and depression. Targeted interventions can mitigate these issues and enhance diabetes management[16].

METHODOLOGY:

This study examined the relationship between sleep disorders and Type 2 Diabetes Mellitus (T2DM). The research involved a comprehensive review of existing literature on sleep quality, glycemic control, and T2DM management. Key databases were searched for studies investigating sleep disorders in T2DM patients, focusing on prevalence, bidirectional links with glycemic control, and impact on quality of life. Studies assessing sleep quality using the Stop-Bang



Questionnaire and glycated hemoglobin (HbA1c) levels were prioritized. Data on risk factors like obesity, diabetes duration, and comorbidities were also analyzed. The study aimed to identify targeted interventions for improving sleep health and diabetes outcomes in T2DM patients

RESULT

This study highlights a significant relationship between sleep disorders and Type 2 Diabetes Mellitus (T2DM). Approximately 66.4% of T2D patients experience sleep disturbances, compared to 8.2% of non-diabetics (Hashimoto et al.). Poor sleep quality is linked to worse glucose control, increased insulin resistance, and higher HbA1c levels. T2D patients report worse sleep quality than the general population, impacting self-management, mental health, and quality of life. Sleep deprivation reduces insulin sensitivity and impairs glucose regulation. Poor sleep correlates with increased risk of cardiovascular disease, retinopathy, and neuropathy. Risk factors for sleep disturbances in T2D include obesity, diabetes duration, and comorbidities like cardiovascular disease and depression. Sleep disorders impair quality of life, daytime functioning, and psychosocial well-being. The bidirectional relationship between sleep and T2DM suggests that addressing sleep issues can improve glycemic control and overall health outcomes. Targeted interventions focusing on sleep quality may enhance diabetes management and reduce complications.

DISCUSSION

The bidirectional relationship between sleep disorders and T2DM highlights the importance of addressing sleep issues in diabetes management. Poor sleep quality is linked to increased insulin resistance, worsened glycemic control, and higher risk of complications. Factors like peripheral

neuropathy pain, nocturia, and depression contribute to sleep disturbances in T2D patients. The study's findings support incorporating sleep assessments into routine diabetes care. Targeted interventions, such as cognitive behavioral therapy for insomnia or sleep hygiene education, may improve sleep quality and glycemic control. Addressing sleep disorders can enhance overall health outcomes and quality of life for T2D patients

CONCLUSION

This study underscores the critical link between sleep disorders and Type 2 Diabetes Mellitus (T2DM). With 66.4% of T2D patients experiencing sleep disturbances, addressing sleep issues is vital for improving health outcomes and quality of life. Poor sleep quality is associated with worsened glycemic control, increased insulin resistance, and higher risk of complications like cardiovascular disease and neuropathy. The bidirectional relationship between sleep and T2DM suggests that targeted interventions, such as sleep hygiene education and cognitive behavioral therapy, can enhance diabetes management. Healthcare providers should prioritize sleep assessments and interventions to mitigate sleep-related issues and improve overall well-being for T2D patients

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