Review Article

The Association between Type 1 Diabetes and Sleep Quality: A Systematic Review

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ABSTRACT

The complex interplay between sleep quality and glycemic control in individuals with type 1 diabetes (T1D) warrants comprehensive investigation. This systematic review aims to evaluate their relationship, with a focus on outcomes such as HbA1c, glucose variability, and nocturnal hyperglycemia. A comprehensive search of four databases led to the discovery of 2116 relevant publications. After eliminating duplicates and assessing each article for relevance, 103 full-text articles were examined, and ultimately, 10 studies were selected based on the inclusion criteria. Ten studies were included, with a total of 803 patients with T1D and 411 (51.2%) were females. Findings across studies were mixed. While some showed significant associations between poor sleep and higher HbA1c or greater glucose variability, others found no direct correlation. Notably, poor sleep was consistently linked with increased nocturnal hyperglycemia, elevated time above range (TAR), and reduced self-reported diabetes management efficacy. Sleep disturbances are prevalent in individuals with T1D and may negatively influence glycemic stability and overall disease management. While the relationship with HbA1c remains inconsistent, the impact of sleep on glucose variability and behavioral outcomes is evident. Integrating sleep assessment into routine diabetes care may improve both metabolic and quality-of-life outcomes. This highlights sleep disturbances as a significant factor in T1D management, underscoring the importance of integrating routine sleep assessment into clinical care for optimized metabolic and quality-of-life outcomes.

Keywords: Diabetes; Type 1 diabetes; glycemic control; HbA1C; Sleep quality; systematic review.

Introduction

The chronic and complex autoimmune disease known as type 1 diabetes is typified by hyperglycemia brought on by a complete lack of insulin secretion as a result of the death of pancreatic β-cells [1].

With an increasing global prevalence, T1D represents a significant public health challenge, especially as it typically affects children and adolescents. Numerous problems, including as cardiovascular disease,

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neuropathy, and retinopathy, may result from it [2]. Effective management of T1D is essential not only for maintaining optimal glycemic levels but also for preventing these long-term complications. Among the various factors influencing T1D management, an often-overlooked yet important component is the quality of sleep experienced by individuals with diabetes [3]. The relationship between sleep and health has been well recognized for decades, yet its specific implications for T1D remain an area of active investigation. Sleep quality—defined by duration, efficiency, and subjective restfulness—has been linked to critical physiological processes including hormonal regulation, metabolism, and cognitive functioning [4]. While poor sleep quality and sleep disorders such as insomnia and obstructive sleep apnea have been strongly associated with an increased risk of developing type 2 diabetes [5], recent research has begun to reveal similar concerns in those living with T1D. Individuals with T1D often report more frequent sleep disturbances than the general population, including insomnia, restless leg syndrome, and disrupted sleep due to nocturnal hypoglycemia or continuous glucose monitoring alarms [6]. These disturbances are not merely symptomatic but may actively contribute to poor glycemic control. Evidence suggests that sleep deprivation impairs insulin sensitivity, increases fasting glucose levels, and disrupts circadian regulation of glucose metabolism. Additionally, poor sleep can heighten stress and anxiety levels, further complicating self-management tasks such as glucose monitoring, insulin dosing, and dietary adherence [7]. Despite the growing body of evidence connecting sleep disturbances to impaired diabetes control, sleep assessment is rarely incorporated into routine T1D management. Current guidelines tend to focus on insulin therapy, nutrition, physical activity, and glycemic monitoring, often excluding sleep as a modifiable behavioral factor. However, addressing sleep disturbances could enhance both metabolic control and overall quality of life in individuals with T1D [8]. Emerging evidence supports the role of sleep quality as a significant factor in metabolic health, including glycemic regulation. Nevertheless, findings have been inconsistent, and the complex relationship between sleep and glycemic outcomes in T1D remains insufficiently explored. This study holds substantial relevance for healthcare providers, patients, and policymakers. A deeper understanding of how sleep quality affects diabetes control could lead to more effective, holistic management strategies. It could also support the development of targeted interventions to improve sleep hygiene, ultimately enhancing outcomes for individuals living with T1D. The aim of this systematic review is to synthesize existing research to better understand the complex relationship between sleep quality and diabetes control in individuals with T1D.

Methods

To maintain scientific rigour and openness, this systematic review complied with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [9] criteria. In order to assess possible neurobiological connections, clinical correlations, and therapeutic implications, the study sought to compile the body of research on the relationship between diabetes control and sleep quality.

Search Strategy: Several databases, including PubMed, Web of Science, Scopus, and ScienceDirect, were thoroughly searched electronically to find pertinent English-language research on the connection between sleep quality and metabolic or diabetes control outcomes. The following Medical Subject Headings (MeSH) phrases and keywords were used in the search strategy:

• Sleep quality (e.g., "sleep disturbances," "insomnia," "sleep duration," "sleep fragmentation")
• Diabetes control (e.g., "glycemic control," "HbA1c," "fasting glucose," "insulin resistance")
• Associated outcomes (e.g., "diabetes complications," "metabolic dysregulation," "glucose variability")

Study Selection and Eligibility Criteria: Two independent reviewers screened search results, assessed study eligibility, extracted data, and evaluated study quality using standardized tools. Any discrepancies were resolved through discussion or consultation with a third reviewer when necessary.

Inclusion Criteria:

• Studies investigating adult populations (>18 years) with type 1 or type 2 diabetes.
• Participants with T1D only.
• Assessment of sleep quality using validated measures (e.g., Pittsburgh Sleep Quality Index [PSQI], actigraphy, polysomnography).
• Evaluation of diabetes control through objective measures (e.g., HbA1c, fasting glucose, continuous glucose monitoring [CGM] data).
• English-language clinical trials and peer-reviewed observational research (cross-sectional, case-control, and cohort).
• Studies published within the last 5 years (2020-2025).

Exclusion Criteria:

• Studies not reporting on the sleep-diabetes association.

• Animal studies, reviews, editorials, case reports with small sample sizes (<10 subjects), or conference abstracts.
• Studies without appropriate control groups or those examining sleep disorders in combination with other metabolic conditions without separate analysis.

Data Extraction: The screening process was managed using Rayyan (QCRI) [10] to enhance transparency and minimize bias. After initial title/abstract screening, full-text articles of eligible studies were reviewed. A standardized extraction form was used to collect study characteristics (author, year, country, design), population details (sample size, diabetes type, sleep assessment method), key outcomes (glycemic control, diabetes complications, metabolic parameters), and statistical findings (adjusted risk estimates, confounders, significance levels).

Risk of Bias Assessment: The included studies' methodological quality underwent a thorough evaluation. Using the Risk of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool, non-randomized studies were evaluated [11]. Cohort and case-control studies were assessed using the Newcastle-Ottawa Scale (NOS), which assigned scores to research in three areas: exposure/outcome, comparability, and selection. A consensus discussion was used to settle any differences between the two reviewers who independently evaluated the possibility of bias.

Results

The search process initially identified 2116 publications (Figure 1). After removing 1209 duplicates, 907 trials were screened based on their titles and abstracts. Of these, 799 did not meet the eligibility criteria, leaving 103 full-text articles for in-depth evaluation. In the end, 10 studies met the inclusion criteria and were selected for evidence synthesis and analysis. Sociodemographic and clinical outcomes: Ten studies were included, with a total of 803 patients with T1D and 411 (51.2%) were females. The study designs consisted of four cross-sectional studies [15, 17, 18, 20], three of which were case-control studies [14, 19, 21], two were quantitative descriptive studies [12, 13], and one was a retrospective observational study [16]. Three studies were conducted in Turkey [14, 17, 19], two in the UK [12, 13], one in Saudi Arabia [15], one in Switzerland [16], one in the USA [18], one in Egypt [20], and one in New Zealand [21] (Table 1). Studies reviewed highlight mixed findings regarding the relationship between sleep quality and glycemic control in individuals with T1D. Several investigations found that poorer subjective sleep quality was associated with higher HbA1c levels, suggesting worse glycemic control. In particular, lower perceived sleep quality and increased variability in sleep patterns were linked to greater glucose variability and elevated A1c levels, indicating that sleep disturbances may compromise metabolic stability [12,13,18]. Conversely, other studies did not observe significant associations between sleep quality and HbA1c. For instance, some research found no correlation between HbA1c and either sleep duration, quality, or sleep-related symptoms when assessed through validated tools such as the Pittsburgh Sleep Quality Index (PSQI) or Sleep Disturbance Scale for Children (SDSC) [14,15, 20, 21]. In these cases, while subjective or behavioral sleep problems were prevalent, they did not consistently predict objective glycemic outcomes. Interestingly, in one study, poorer sleep was associated with increased nocturnal hyperglycemia, particularly reflected in a higher percentage of time spent above range during sleep hours (TAR2), despite no significant association with HbA1c itself [16]. Another study involving children and adolescents revealed that higher HbA1c was correlated with greater overall sleep disturbance and excessive daytime sleepiness, underscoring potential behavioral consequences of poor glycemic control on sleep quality [19]. Furthermore, poor sleep was frequently associated with other negative outcomes beyond glycemic control, such as emotional dysregulation, higher body mass index (BMI), lower quality of life, and psychological issues like alexithymia or depression, which may indirectly impact diabetes management [17, 19, 20]. (Table 2) shows risk of bias assessment using ROBINS-I, studies such as those conducted by Griggs et al. [12,13] and Alhoqail et al. [15] consistently exhibit low levels of bias across many categories, indicating robust research practices. In contrast, other studies, such as those by Berk & ÇELIK [17] and Hamburger et al. [20], reveal moderate bias in multiple categories.

Discussion

The findings of this review underscore the growing recognition of sleep quality as a critical, yet underappreciated, factor in the management of T1D. Across the studies analyzed, a consistent theme emerges: individuals with T1D, particularly children, adolescents, and young adults, frequently experience sleep disturbances that may adversely impact glycemic control. Although not all studies demonstrated a direct relationship between sleep quality and HbA1c, several highlighted significant

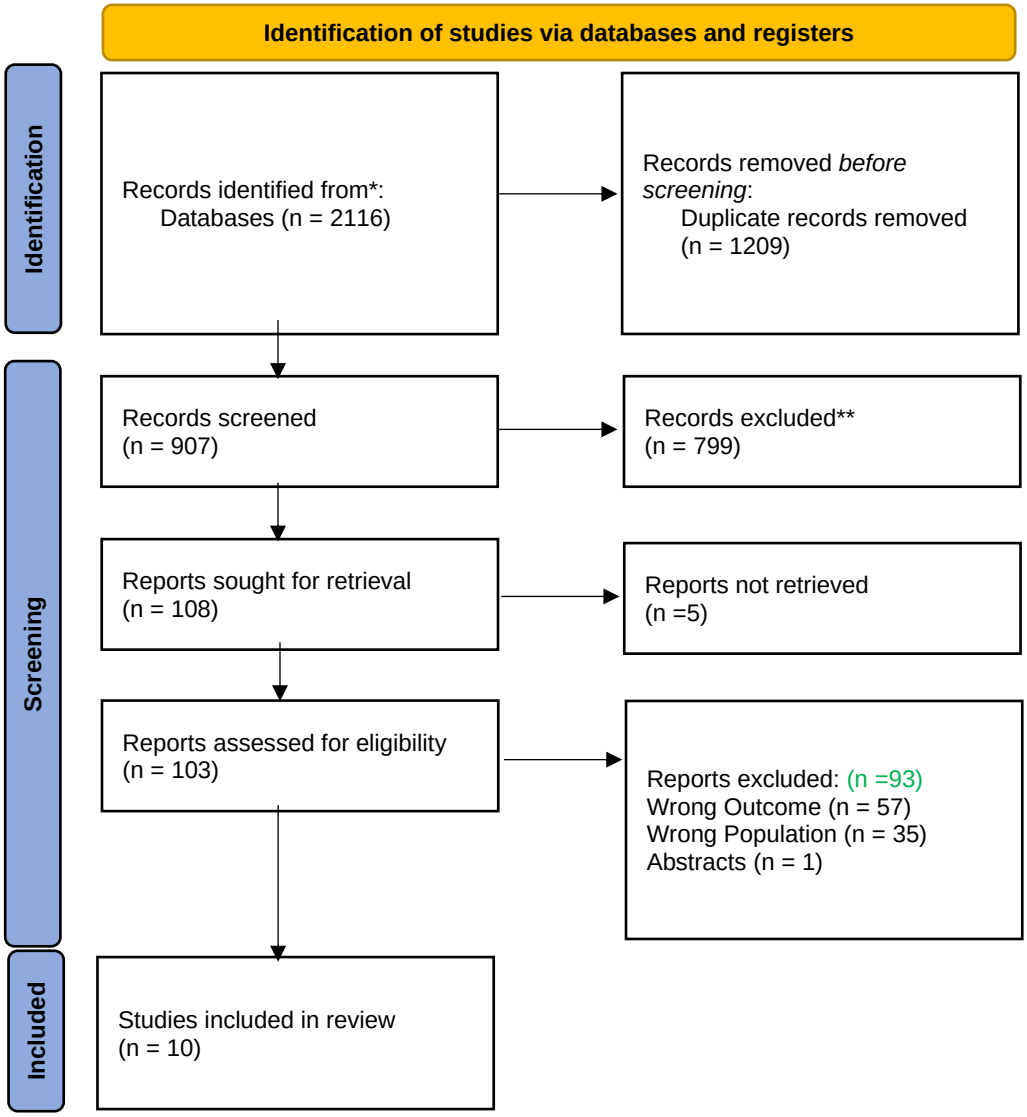

Figure 1: Search summary illustrated in PRISMA flowchart.

Table 1: Summary of the included studies.

Study ID	Country	Study design	Sociodemographic	Mean HbA1C (SD)	Mean T!D duration (SD)	Sleep assessment tool	Main outcomes
Griggs et al., 2023 [12]	UK	A quantitative descriptive study	Cases: 69 Mean age: 21.4 Females: 48 (69.6%)	6.9 (1)	9.7 (5.6)	19-item PSQI	Lower perceived sleep quality is associated with poorer control of T1D. Specifically, individuals reporting lower sleep quality tend to have higher A1C levels, indicating worse glycemic control
Griggs et al., 2021 [13]	UK	A quantitative descriptive study	Cases: 46 Mean age: 22.3 Females: 21 (45.7%)	7.2 (1.1)	10.3 (6)	Self-reported	Increased variability in sleep patterns was significantly linked to higher fluctuations in blood glucose levels ($r = 0.33$, $P = 0.036$), while elevated levels of

							daytime sleepiness demonstrated an even stronger connection to glucose variability (r = 0.50, P = 0.001).
Çömlek et al., 2021 [14]	Turkey	Case-control	Cases: 58 Mean age: 14.3 Females: 28 (48%)	8.8 (1.9)	4.8 (2.7)	PSQI	The study found no significant association between sleep quality, duration of T1D, and HbA1c levels within the diabetes group (P = 0.59 and P = 0.41, respectively).
Alhoqail et al., 2024 [15]	Saudi Arabia	Cross-sectional	Cases: 182 Mean age: 35.5 Females: 91 (50%)	8.66 (1.98)	14.97 (9.82)	PSQI	The mean HbA1c was 8.68 ± 1.91%, indicating suboptimal glycemic control in the study population. However, no correlation was found between HbA1c levels

							and overall sleep quality (PSQI score) or its components.
Pantanetti et al., 2025 [16]	Switzerland	Retrospective observational study	Cases: 41 Mean age: 51.9 Females: 17 (41.5%)	NM	25.1 (14.6)	PSQI	Poor sleep quality in T1D patients is significantly associated with increased nocturnal hyperglycemia, particularly reflected in higher TAR2 during bedtime hours.
Berk & ÇELIK, 2023 [17]	Turkey	Cross-sectional	Cases: 61 Mean age: 11.8 Females: 33 (54.1%)	8.82 (1.92)	4.32 (2.89)	SDSC	The high SDSC score group (indicating poorer sleep) had: Shorter diabetes duration (DD) ($p = 0.01$) Higher HbA1c levels ($p = 0.02$) Suggests that poorer glycemic control is associated with worse sleep.

Brandt et al., 2021 [18]	USA	Cross-sectional	Cases: 20 Mean age: 30 Females: 10 (50%)	6.6 (0.7)	15.7 (10.4)	Home sleep assessments and CGM	Poor sleep quality was significantly associated with: Higher glucose standard deviation (SD): Coefficient: 0.39, 95% CI [0.10, 0.67], p = 0.009
Donbaloğlu et al., 2024 [19]	Turkey	Case-control	Cases: 144 Mean age: 10.3 Females: 72 (50%)	8.4 (7.5 – 10.2)	5	SDSC	Correlation Between HbA1c and Sleep Problems: HbA1c positively correlated with: Disorders of excessive somnolence (DOES): p < 0.001, R = 0.368 Total SDSC scores: p = 0.003, R = 0.243 This means higher HbA1c was associated with more severe overall sleep disturbances and greater

							daytime sleepiness.
Hamburger et al., 2020 [20]	Egypt	Cross-sectional	Cases: 118 Mean age: 9.3 Females: 60 (50.8%)	NM	3.37 (2.5)	CSHQ-A	sleep problems were common (59.3%), but no direct association with HbA1c or glycemic control in T1D was reported.
Rose et al., 2021 [21]	New Zealand	Case-control	Cases: 64 Mean age: 16.6 Females: 31 (48%)	10.9 (1.7)	7.5 (3.8)	PSQI	Youth with high-risk T1D reported poorer subjective sleep quality, including later bedtimes and shorter sleep duration, despite no significant differences in objectively measured sleep compared to controls. However, no direct association was found between HbA1c or glycemic control and sleep measures

Table 2: Risk of bias assessment using ROBINS-I.

Study ID	Bias due to confounding	Bias in the selection of participants into	Bias in the classification of interventions	Bias due to deviations from the intended interval	Bias due to missing data	Bias in he measurement of outcomes	Bias in the selection of reported result	Overall bias
Griggs et al., 2023 [12]	Low	Low	Mod	Low	Low	Low	Mod	Low
Griggs et al., 2021 [13]	Low	Low	Mod	Low	Low	Low	Mod	Low
Çömlek et al., 2021 [14]	Mod	Low	Low	Low	Low	Mod	Low	Low
Alhoqail et al., 2024 [15]	Low	Low	Mod	Low	Low	Low	Mod	Low
Pantanetti et al., 2025 [16]	Low	Low	Mod	Low	Low	Low	Mod	Low
Berk & ÇELIK, 2023 [17]	Mod	Mod	Low	Low	Low	Mod	Mod	Moderate
Brandt et al., 2021 [18]	Mod	Mod	Low	Low	Low	Mod	Low	Moderate
Donbaloğlu et al., 2024 [19]	Mod	Mod	Low	Low	Low	Mod	Mod	Moderate
Hamburger et al., 2020 [20]	Mod	Mod	Low	Mod	Low	Mod	Low	Moderate
Rose et al., 2021 [21]	Mod	Mod	Low	Low	Low	Mod	Low	Moderate

associations between poor sleep and increased glucose variability, nocturnal hyperglycemia, and reduced time in range (TIR). These metrics reflect the short-term instability of glucose levels that HbA1c alone may not capture, suggesting that sleep quality exerts more nuanced effects on glycemic control than previously appreciated. Ji et al. [22], demonstrated that elevated A1C levels and inadequate self-care behaviors in individuals with T1D were linked to both short and prolonged sleep duration, low sleep quality, frequent sleep disturbances, and irregular sleep patterns. These associations were especially prominent among adolescent males, young adult men, and individuals from immigrant backgrounds. Moreover, self-care behaviors played a mediating role in the relationship between sleep patterns and later A1C outcomes [22]. A later meta-analysis (including studies up to around 2015) found that adults with T1D who reported sleeping 6 hours or less had A1C levels that were 0.24% higher, on average, compared to those who slept more than 6 hours. Similarly, individuals reporting poor sleep quality had A1C levels that were 0.19% higher than those with good sleep quality [23]. These differences in A1C were comparable to those observed in people with type 2 diabetes [4]. However, the same meta-analysis found no significant differences in glycemic control when sleep duration or quality was assessed using objective measures [23]. Furthermore, the bidirectional nature of the relationship between sleep and glycemic control must be emphasized. While poor sleep may impair glucose regulation through hormonal and behavioral mechanisms, hyperglycemia and hypoglycemia themselves can disrupt sleep, creating a vicious cycle that complicates diabetes management. Several studies also pointed to the potential moderating effects of age, diabetes duration, mental health status, and co-existing conditions such as obesity or emotional dysregulation, further illustrating the multifactorial nature of this association [24]. Stage N3 sleep is physiologically associated with a restorative period and decreased sympathetic nervous system activity, which may help explain how it is linked to better glycaemic management [25]. While the exact mechanism was not examined, it was suggested that difficulty sleeping might lead to increased insulin resistance, potentially triggering the onset of diabetes in vulnerable individuals [26]. In the study, objective sleep quality was measured using sleep efficiency from a single night of polysomnography (PSG), while subjective sleep assessments reflected experiences over the previous month. Interestingly, there were only a small number of PSG participants in the analysis. Numerous factors, including neuropathic pain [27], hypoglycemic episodes (which can result in increased carbohydrate intake the following morning [28]), fragmented sleep, and psychological stressors, can cause sleep disturbances in people with type 1 diabetes. These factors are all linked to poorer glycaemic control [29]. Importantly, this review highlights the subjective nature of sleep complaints among individuals with T1D, with several studies reporting discrepancies between subjective and objective sleep measurements. For example, many patients rated their sleep quality as poor despite minimal differences in actigraphy-derived sleep parameters compared to controls. This discrepancy may be explained by psychosocial factors, diabetes-related anxieties, or frequent nocturnal awakenings linked to glucose monitoring or insulin management. Such experiences may not always manifest in objective metrics but have real-world implications for emotional well-being and disease self-management. The literature reveals considerable variability in outcomes depending on whether sleep is assessed objectively—using tools like electroencephalograms or accelerometers—or subjectively, through sleep diaries or questionnaires [30]. For instance, O'Brien et al. highlighted this discrepancy, showing that actigraphy recorded total sleep time to be approximately one hour shorter than what participants reported in their sleep diaries [31]. Despite such differences in measurement methods, the overall trend remains consistent: disturbances in sleep and circadian rhythms are associated with an elevated risk of diabetes onset and poorer glycemic outcomes. Nevertheless, several important gaps in knowledge remain. There is limited understanding of how common circadian rhythm disturbances are among individuals with diabetes, and more research is needed to evaluate how interventions targeting these disturbances affect glycemic control. Additionally, clinical observations—such as increased frequency of nightmares during episodes of nocturnal hypoglycemia—present practical phenomena that merit further exploration [32].

Strengths: This review contributes meaningfully to the literature by providing an up-to-date synthesis of studies exploring the link between sleep quality and glycemic control in individuals with T1D. It incorporates a wide age range, from pediatric to adult populations, and highlights both subjective and objective assessments of sleep, offering a comprehensive overview of the current evidence base.

Furthermore, the inclusion of studies from diverse geographic and healthcare settings enhances the generalizability of the findings and underscores the global relevance of sleep in T1D management.

Limitations: Despite these strengths, several limitations must be acknowledged. First, the heterogeneity in study designs, sample sizes, and sleep assessment tools limited the ability to draw definitive conclusions or perform meta-analytic comparisons. Many studies relied heavily on subjective sleep measures, which are prone to bias and may not accurately reflect physiological sleep quality. In addition, variations in CGM usage, insulin regimens, and patient adherence were not consistently controlled for, potentially confounding observed associations. Lastly, most studies were cross-sectional in nature, precluding causal inferences regarding the directionality of the sleep-glycemic control relationship.

Conclusion

This review highlights a compelling yet underexplored dimension of T1D care: the impact of sleep quality on glycemic outcomes. While findings remain mixed regarding the association between sleep and HbA1c, evidence strongly supports the role of sleep disturbances in influencing glucose variability, nocturnal control, and self-management behaviors. Incorporating sleep assessments into routine diabetes care may offer a practical and holistic strategy to optimize outcomes.

Conflict of Interest

None

Funding

None

References

1. Mehrdad M, Azarian M, Sharafkhaneh A, Alavi A, Zare R, Rad AH, et al. Association between poor sleep quality and glycemic control in adult patients with diabetes referred to Endocrinology Clinic of Guilan: a cross-sectional study. Int J Endocrinol Metab. 2021;20(1):e118077.
2. Shibabaw YY, Dejenie TA, Tesfa KH. Glycemic control and its association with sleep quality and duration among type 2 diabetic patients. Metab Open. 2023;18:100246.
3. Surani S, Brito V, Surani A, Ghamande S. Effect of diabetes mellitus on sleep quality. World J Diabetes. 2015;6(6):868.
4. Salsa SF, Kurniasari S, Anita F. Relationship between Sleep Quality and Blood Sugar Levels in Patients with Type II Diabetes Mellitus. Java Nurs J. 2025;3(2):147-54.
5. Richa R, Datta N, Raj V, Kumar R, Venugopal V. Sleep Quality in Type 2 Diabetes Mellitus Patients Attending a Tertiary Care Hospital in West Bengal: A Cross-Sectional Study. Cureus. 2023;15(9):e46139.
6. Lee SW, Ng KY, Chin WK. The impact of sleep amount and sleep quality on glycemic control in type 2 diabetes: a systematic review and meta-analysis. Sleep Med Rev. 2017;31:91-101.
7. Borzouei S, Ahmadi A, Pirdehghan A. Sleep quality and glycemic control in adults with type 2 diabetes mellitus. J Family Med Prim Care. 2024;13(8):3398-402.
8. Tsai YW, Kann NH, Tung TH, Chao YJ, Lin CJ, Chang KC, et al. Impact of subjective sleep quality on glycemic control in type 2 diabetes mellitus. Fam Pract. 2012;29(1):30-5.
9. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
10. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Rev. 2016;5:210.
11. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;355:i4919.
12. Griggs S, Huynh J, Rieke J, Howard Q. The role of perceived sleep quality in cardiovascular health factors and behaviors among young adults with type 1 diabetes. Sci Diabetes Self Manag Care. 2023;49(5):384-91.
13. Griggs S, Hickman Jr RL, Strohl KP, Redeker NS, Crawford SL, Grey M. Sleep-wake characteristics, daytime sleepiness, and glycemia in young adults with type 1 diabetes. J Clin Sleep Med. 2021;17(9):1865-74.
14. Çömlek FÖ, Çelik H, Keskin B, Süt N, Dilek E, Tütüncüler F. Sleep quality assessment in adolescents with and without type 1 diabetes using the Pittsburg Sleep Quality Index. Indian J Endocrinol Metab. 2021;25(3):202-5.
15. Alhoqail AA, Aburisheh KH, Alammar AM, Bin Mugren MA, Shadid AM, Aldakhil IK, et al. Sleep Quality Assessment and Its Predictors Among Saudi Adults with Type 1 and Type 2 Diabetes: A Cross-Sectional Study. Int J Environ Res Public Health. 2024;21(11):1437.
16. Pantanetti P, Biondini F, Mancin S, Sguanci M, Masini A, Panella M, et al. Sleep Quality and Glycemic Control in Type 1 Diabetes: A Retrospective Cohort Study Using Advanced Technological Devices. Diabetology. 2025;6(3):21.

17. Berk E, ÇELIK N. Sleep quality and glycemic control in children and adolescents with type 1 diabetes mellitus. Eur Rev Med Pharmacol Sci. 2023;27(10):4535-42.
18. Brandt R, Park M, Wroblewski K, Quinn L, Tasali E, Cinar A. Sleep quality and glycaemic variability in a real-life setting in adults with type 1 diabetes. Diabetologia. 2021;64(10):2159-69.
19. Donbaloğlu Z, Çetiner EB, Yüksel Aİ, Singin B, Behram BA, Bedel A, et al. Sleep disturbances in children and adolescents with type 1 diabetes mellitus: prevalence, and relationship with diabetes management. Sleep Med. 2024;115:55-60.
20. Hamburger ER, Goethals ER, Choudhary A, Jaser SS. Sleep and depressive symptoms in adolescents with type 1 diabetes not meeting glycemic targets. Diabetes Res Clin Pract. 2020;169:108442.
21. Rose S, Boucher SE, Galland BC, Wiltshire EJ, Stanley J, Smith C, et al. Impact of high-risk glycemic control on habitual sleep patterns and sleep quality among youth (13-20 years) with type 1 diabetes mellitus compared to controls without diabetes. Pediatr Diabetes. 2021;22(5):823-31.
22. Ji X, Wang Y, Saylor J. Sleep and type 1 diabetes mellitus management among children, adolescents, and emerging young adults: a systematic review. J Pediatr Nurs. 2021;61:245-53.
23. Reutrakul S, Thakkinstian A, Anothaisintawee T, Chontong S, Borel AL, Perfect MM, et al. Sleep characteristics in type 1 diabetes and associations with glycemic control: systematic review and meta-analysis. Sleep Med. 2016;23:26-45.
24. Mosavat M, Mirsanjari M, Arabiat D, Smyth A, Whitehead L. The Role of Sleep Curtailment on Leptin Levels in Obesity and Diabetes Mellitus. Obes Facts. 2021;14(2):214-21.
25. Dijk DJ. Slow-wave sleep, diabetes, and the sympathetic nervous system. Proc Natl Acad Sci U S A. 2008;105(4):1107-8.
26. Olsson L, Ahlbom A, Grill V, Midthjell K, Carlsson S. Sleep disturbances and low psychological well-being are associated with an increased risk of autoimmune diabetes in adults. Results from the Nord-Trøndelag Health Study. Diabetes Res Clin Pract. 2012;98(2):302-11.
27. Bouhassira D, Letanoux M, Hartemann A. Chronic pain with neuropathic characteristics in diabetic patients: a French cross-sectional study. PLoS One. 2013;8(9):e74195.
28. Schmid SM, Jauch-Chara K, Hallschmid M, Oltmanns KM, Born J, Schultes B. Short-term nocturnal hypoglycaemia increases morning food intake in healthy humans. Diabet Med. 2008;25(2):232-5.
29. Tasali E, Leproult R, Ehrmann DA, Van Cauter E. Slow-wave sleep and the risk of type 2 diabetes in humans. Proc Natl Acad Sci U S A. 2008;105(3):1044-9.
30. Lustman PJ, Anderson RJ, Freedland KE, De Groot M, Carney RM, Clouse RE. Depression and poor glycemic control: a meta-analytic review of the literature. Diabetes Care. 2000;23(7):934-42.
31. Kripke DF, Langer RD, Elliott JA, Klauber MR, Rex KM. Mortality related to actigraphic long and short sleep. Sleep Med. 2011;12(1):28-33.
32. O'Brien E, Hart C, Wing RR. Discrepancies between self-reported usual sleep duration and objective measures of total sleep time in treatment-seeking overweight and obese individuals. Behav Sleep Med. 2016;14(5):539-49.
33. Frier BM. How hypoglycaemia can affect the life of a person with diabetes. Diabetes Metab Res Rev. 2008;24(2):87-92.