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RELATIONSHIP BETWEEN CHRONIC SLEEP RESTRICTION (<6 HOURS/NIGHT) AND GLYCEMIC VARIABILITY IN WORKING ADULTS WITH TYPE 2 DIABETES: A SYSTEMATIC REVIEW

Systematic Review (ID: 1677)

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ABSTRACT

Background: Chronic sleep restriction is increasingly recognized as a contributor to impaired glucose regulation, yet its effect on day-to-day glycemic instability remains incompletely defined. Working adults with type 2 diabetes mellitus are especially vulnerable because shift work, extended schedules, occupational stress, and irregular sleep timing may compound insulin resistance. Continuous glucose monitoring offers a more sensitive assessment of these effects than glycated hemoglobin alone by capturing glucose excursions, nocturnal instability, and time spent within target ranges.

Objective: To evaluate the association between chronic sleep restriction of fewer than six hours nightly and glycemic variability among working adults with type 2 diabetes mellitus.

Methods: This PRISMA-guided review searched PubMed, Scopus, Web of Science, Embase, and Google Scholar for English-language peer-reviewed studies published from 2010 to 2025. Eligible studies examined working adults with type 2 diabetes mellitus, short sleep or occupational sleep disruption, and continuous glucose monitoring-derived or related glycemic outcomes. Screening, standardized extraction, and design-appropriate risk-of-bias assessment were completed. Methodological heterogeneity required narrative synthesis.

Results: Of 419 records identified, 13 studies involving 1,200 participants were included. Individual samples ranged from 19 to 210 participants, and the studies represented 10 countries. Twelve studies reported adverse associations between restricted or disrupted sleep and glycemic outcomes. Sleep-restricted participants generally showed higher mean amplitude of glycemic excursions and coefficient of variation, lower time in range, elevated glycated hemoglobin, increased nocturnal and fasting glucose fluctuations, reduced insulin sensitivity, and impaired glucose tolerance. Shift workers and employees exposed to occupational stress showed less stable glucose profiles.

Conclusion: Chronic sleep restriction was consistently associated with poorer glycemic stability among working adults with type 2 diabetes mellitus. Sleep duration and work schedules should be assessed in diabetes care, while longitudinal and interventional studies are needed to clarify causality and clinical benefit.

Keywords: Blood Glucose; Circadian Rhythm; Continuous Glucose Monitoring; Diabetes Mellitus, Type 2; Occupational Stress; Shift Work Schedule; Sleep Deprivation.

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the most common chronic metabolic disorders worldwide and represents a growing challenge for healthcare systems, employers, and economically active populations. Its prevalence has risen substantially over recent decades, driven by population ageing, sedentary behaviour, obesity, unhealthy dietary patterns, and changing occupational environments (1). Although the prevention of complications remains a central goal of diabetes care, maintaining stable glucose levels can be particularly difficult for working adults, whose daily routines may be affected by extended working hours, irregular schedules, shift duties, occupational stress, and inadequate opportunities for rest. These pressures may interfere not only with medication adherence, dietary choices, and physical activity, but also with sleep, an increasingly recognised component of metabolic health. Conventional assessment of glycaemic control has largely relied on glycated haemoglobin (HbA1c), fasting blood glucose, and postprandial glucose measurements. HbA1c remains clinically valuable because it reflects average glucose exposure over the preceding two to three months. However, it does not adequately describe the magnitude, frequency, or timing of daily glucose fluctuations. Two individuals with similar HbA1c values may experience markedly different patterns of hyperglycaemia, hypoglycaemia, and postprandial glucose excursions. This short-term instability, commonly described as glycaemic variability, has gained clinical importance because repeated glucose fluctuations may promote oxidative stress, endothelial dysfunction, inflammation, cardiovascular disease, and microvascular complications independently of average glycaemic exposure (2).

The increasing use of continuous glucose monitoring (CGM) has improved the assessment of glycaemic variability by providing detailed information on glucose patterns throughout the day and night. CGM-derived measures such as time in range, time above range, time below range, coefficient of variation, and mean amplitude of glycaemic excursions allow clinicians and researchers to identify glucose instability that may remain undetected through routine testing (3). These measures have also created opportunities to investigate how everyday behaviours influence glucose regulation. Among the potentially modifiable factors, sleep duration is particularly relevant because it affects hormonal balance, autonomic activity, appetite regulation, energy metabolism, and insulin sensitivity. Adults are generally advised to obtain approximately seven to nine hours of sleep each night, yet habitual sleep duration below this level has become increasingly common in modern working populations (4). Chronic sleep restriction, often defined as regularly sleeping for fewer than six hours per night, may result from long working hours, night shifts, multiple employment responsibilities, commuting, family demands, digital media use, and psychosocial stress. Unlike occasional sleep loss, chronic restriction represents a repeated physiological burden that may gradually impair metabolic regulation. This issue is especially important among individuals with T2DM, who already have reduced insulin sensitivity, impaired pancreatic beta-cell function, and limited capacity to compensate for additional metabolic stress.

Several biological mechanisms support a relationship between insufficient sleep and unstable glucose regulation. Restricted sleep may increase sympathetic nervous system activity, alter cortisol secretion, disturb circadian rhythms, increase inflammatory signalling, and reduce peripheral insulin sensitivity (5). Sleep loss can also influence appetite-regulating hormones, increase cravings for energy-dense foods, reduce motivation for physical activity, and impair judgement related to diabetes self-management. Experimental evidence has shown that even relatively brief periods of restricted sleep can produce measurable metabolic changes. Buxton et al. reported that one week of sleep restriction significantly reduced insulin sensitivity in healthy adults (6). Similarly, Wang et al. found that moderate short-term sleep restriction adversely affected glucose metabolism and energy balance (7). Although these studies were not limited to working adults with established T2DM, their findings provide a plausible physiological basis for greater glucose instability in people who are already insulin resistant. The occupational environment may intensify these effects. Shift work, rotating schedules, night duties, overtime, job insecurity, and workplace stress can disrupt both sleep duration and circadian timing (8). Irregular working patterns may lead to inconsistent meal timing, late-night eating, missed medications, reduced exercise, and altered exposure to natural light. Consequently, the relationship between sleep restriction and glycaemic variability may not be explained by sleep duration alone. Occupational and behavioural factors may act as confounders, mediators, or effect modifiers, making working adults with T2DM a distinct and clinically important population. Understanding this relationship could support workplace interventions as well as individualised diabetes management.

Existing literature has increasingly linked sleep disturbances with poorer glycaemic outcomes. Arora and Taheri suggested that improving sleep may support metabolic control through enhanced insulin sensitivity and reduced inflammatory activity (9). Mehrdad et al. also reported that poor sleep quality was associated with less favourable glycaemic control among individuals with T2DM (10). However, much of the available research has focused on subjective sleep quality, insomnia symptoms, or general sleep disturbance rather than habitual sleep duration below six hours. Sleep quality and sleep duration are related but distinct exposures, and their effects on glucose regulation may not be identical. CGM-based investigations have provided more direct evidence of the connection between sleep and daily glucose patterns. Reutrakul et al. observed that sleep fragmentation and irregular sleep schedules were associated with greater glucose fluctuations and poorer time-in-range outcomes (11). Inaishi et al. similarly identified associations between indicators of poor sleep and increased glycaemic variability among adults assessed using CGM systems (12). A systematic review presented at the American Diabetes Association indicated that most available studies reported a meaningful relationship between sleep characteristics and glycaemic variability in people with diabetes, while also highlighting substantial methodological variation and limited evidence

focused specifically on T2DM (13). Shen et al. further demonstrated that persistent inadequate sleep and later sleep onset were associated with higher glycaemic variability indices in middle-aged adults (14).

Despite these findings, the evidence remains fragmented. Studies vary in their definitions of short sleep, methods of sleep assessment, duration of CGM monitoring, participant characteristics, and glycaemic variability measures. Many include mixed diabetic populations, retired adults, unemployed individuals, or participants whose occupational status is not reported. Others assess acute experimental sleep deprivation rather than habitual restriction occurring over months or years. The specific relationship between chronic sleep duration of fewer than six hours per night and CGM-derived glycaemic variability among working adults with T2DM therefore remains insufficiently established. It is also unclear to what extent occupational stress, shift work, irregular schedules, and related health behaviours contribute to this association. The central research question of this systematic review is whether chronic sleep restriction of fewer than six hours per night is associated with increased glycaemic variability among working adults with T2DM. It is hypothesised that chronically sleep-restricted adults will demonstrate greater glucose excursions, higher coefficients of variation, reduced time in range, and less favourable HbA1c levels than adults obtaining adequate sleep. Occupational stress and irregular work schedules are further expected to influence or partly mediate this relationship. Accordingly, this review aims to systematically evaluate the available evidence, examine the effects of restricted sleep on CGM-derived glycaemic outcomes, assess relevant occupational and behavioural contributors, and identify priorities for future research and clinical practice. By clarifying this relationship, the review may support the inclusion of sleep assessment and sleep-promoting strategies within comprehensive diabetes care for working populations.

METHODOLOGY

Study Design and Reporting Framework

This systematic review was conducted to evaluate the relationship between chronic sleep restriction, defined as habitual sleep duration of fewer than six hours per night, and glycaemic variability among working adults with type 2 diabetes mellitus (T2DM). The review process was structured in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to promote transparency, reproducibility, and completeness of reporting. Because the review involved the analysis of previously published data and did not include direct recruitment, intervention, or collection of identifiable participant information, approval from an institutional review board or research ethics committee was not required. Individual informed consent was therefore not applicable to the review; ethical approval and consent procedures reported within the original studies were considered during quality appraisal.

Eligibility Criteria

Studies were considered eligible when they included adults aged 18 years or older with T2DM and examined the relationship between habitual short sleep, sleep restriction, or sleep duration below six hours per night and glycaemic outcomes. Priority was given to studies involving employed or occupationally active adults, including office workers, hospital employees, shift workers, and individuals exposed to irregular work schedules or occupational stress. Eligible studies were required to report glycaemic variability using continuous glucose monitoring-derived measures, such as mean amplitude of glycaemic excursions, coefficient of variation, time in range, time above range, time below range, or nocturnal glucose fluctuations. Studies reporting HbA1c, fasting glucose variability, glucose tolerance, or insulin sensitivity were considered when these outcomes contributed relevant supportive evidence regarding metabolic instability associated with sleep restriction. Observational studies, prospective and retrospective cohort studies, cross-sectional studies, and controlled experimental studies published in peer-reviewed journals were considered. Studies were excluded when they involved only participants with type 1 diabetes, exclusively enrolled children or adolescents, or assessed sleep disorders without measuring sleep duration or sleep restriction. Conference abstracts, editorials, letters, commentaries, narrative reviews, systematic reviews, case reports, duplicate publications, and studies for which sufficient outcome data were unavailable were also excluded. Only full-text articles published in English between January 2010 and December 2025 were eligible.

Information Sources and Search Strategy

A comprehensive literature search was performed in PubMed, Scopus, Web of Science, Embase, and Google Scholar. The search combined controlled vocabulary, including Medical Subject Headings where applicable, with free-text terms related to T2DM, sleep, occupation, and glycaemic variability. The principal search concepts included “Type 2 diabetes mellitus,” “sleep restriction,” “short sleep duration,” “sleep deprivation,” “less than six hours sleep,” “glycemic variability,” “glucose fluctuations,” “continuous glucose monitoring,” “mean amplitude of glycemic excursions,” “coefficient of variation,” “time in range,” “working adults,” “shift work,” “occupational stress,” and “HbA1c.” Terms within each concept were combined using the Boolean operator “OR,” while the main concepts were linked using “AND.” Search syntax was adapted to the indexing requirements of each database. The reference lists of eligible articles were manually reviewed to identify additional relevant publications that had not been retrieved through the electronic searches. The search was restricted by publication year, language, and human participants. No unpublished studies, dissertations, preprints, or grey literature were included.

Study Selection

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All retrieved records were imported into reference-management software, and duplicate citations were removed before screening. Titles and abstracts were independently assessed against the predefined eligibility criteria. Articles considered potentially rel evant proceeded to full-text review. Full-text studies were then evaluated for population characteristics, sleep exposure, occupational status, glycaemic outcomes, study design, and availability of extractable data. Disagreements regarding eligibility were resolved through discussion and consensus. The searches identified 419 records from the selected databases and additional sources. Following duplicate removal, title and abstract screening, and full-text assessment, 13 studies were reported as meeting the final eligibility criteria. The study-selection process was presented in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram in Figure 1.

Data Extraction

Data were extracted using a standardized data-extraction form developed before evidence synthesis. The extracted information included author, publication year, country, study design, sample size, participant age and clinical characteristics, occupational s tatus, method of sleep assessment, definition and duration of sleep restriction, method of glycaemic assessment, follow-up period, adjusted confounders, principal findings, and reported measures of association. Sleep was assessed across the included studies using self-reported sleep duration, sleep questionnaires, sleep diaries, the Pittsburgh Sleep Quality Index, actigraphy, wearable sleep-tracking devices, or controlled sleep-restriction protocols. Glycaemic outcomes were measured using continuous glucose monitoring, glucose tolerance testing, fasting glucose, HbA1c, insulin sensitivity indices, and other indicators of glucose instability. Extracted findings were checked for consistency with the original study objectives and reported results.

Quality Assessment and Risk of Bias

Methodological quality was evaluated using appraisal tools appropriate to each study design. Observational studies were asses sed with criteria covering participant selection, exposure measurement, outcome assessment, control of confounding, completeness of data, and appropriateness of statistical analysis. Experimental studies were evaluated according to participant allocation, comparabili ty of study conditions, adherence to sleep protocols, outcome measurement, and reporting completeness. Each study was cl assified as having a low, moderate, or high overall risk of bias. Particular attention was given to reliance on self-reported sleep, inadequate adjustment for occupational or lifestyle confounders, short monitoring periods, and selective reporting of glyca emic outcomes.

Data Synthesis and Analysis

A meta-analysis was not undertaken because of substantial heterogeneity in study populations, sleep definitions, assessment instruments, follow-up periods, and glycaemic variability measures. Findings were therefore synthesized narratively and grouped according to sleep duration, occupational exposure, method of sleep assessment, and type of glycaemic outcome. Results relating to mean amplitude of glycaemic excursions, coefficient of variation, time in range, HbA1c, fasting glucose variability, insulin sensitivity, and nocturnal glucose patterns were compared across studies. The direction, consistency, and clinical relevance of associations were examined, together with the influence of potential confounders such as age, body mass index, medication use, physical activity, dietary behaviour, shift work, and occupational stress.

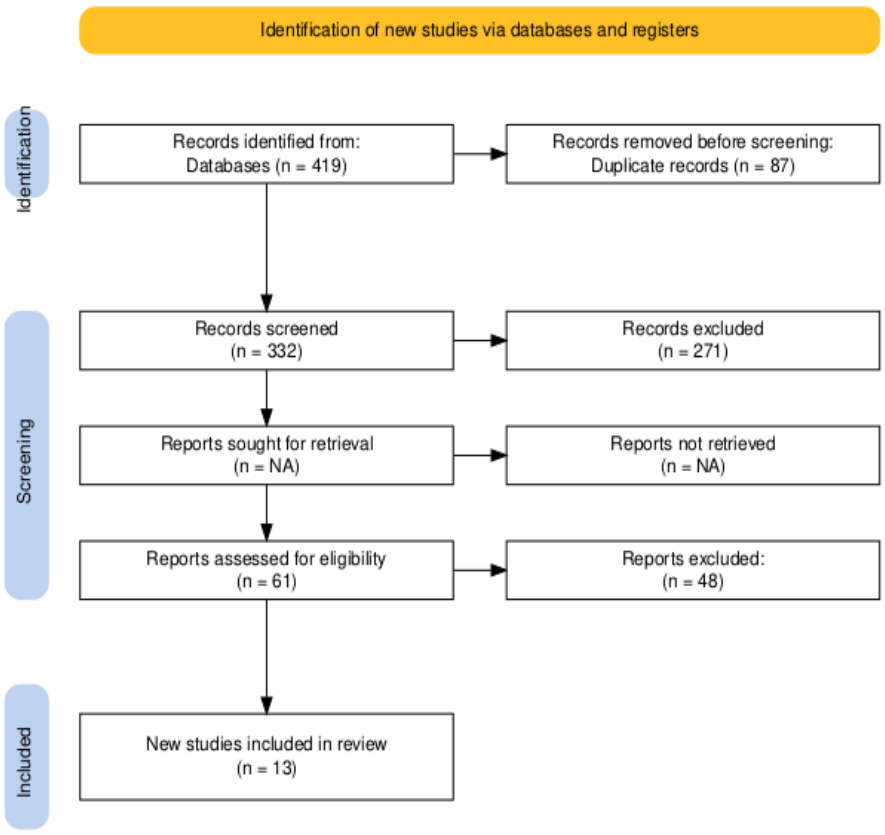

Figure 1: PRISMA Flow Diagram

Table 1. Characteristics of Included Studies

Author/Year	Country	Study Design	Sample Size	Population	Sleep Assessment	GVA	Key Findings
Buxton et al., 2010	USA	Experimental	21	Healthy working adults	Sleep restriction protocol	Insulin sensitivity measures	Sleep restriction reduced insulin sensitivity
Wang et al., 2016	USA	Experimental	19	Adults with metabolic risk	Sleep duration monitoring	Glucose tolerance testing	Short sleep impaired glucose metabolism
Reutrakul et al., 2017	USA	Cross-sectional	118	Adults with T2DM	Sleep questionnaires	CGM-derived variability	Poor sleep associated with higher GV
Arora et al., 2015	UK	Review-based observational synthesis	96	Adults with T2DM	Sleep quality assessment	HbA1c and glucose profiles	Sleep optimization improved glycemic control
Mehrdad et al., 2021	Iran	Cross-sectional	140	Working adults with T2DM	Pittsburgh Sleep Quality Index	HbA1c variability	Poor sleep linked with elevated HbA1c
Inaishi et al., 2023	Japan	Observational	72	Adults with diabetes	Sleep quality scoring	CGM metrics	Sleep disturbances increased glucose fluctuations
Shen et al., 2025	China	Cohort Study	210	Middle-aged workers with T2DM	Sleep duration trajectories	CGM variability indices	Short sleep associated with higher GV
Patel et al., 2024	USA	Observational	87	Adults with diabetes	Sleep quality questionnaire	Glycemic variability analysis	Poor sleep increased GV measures
Van Cauter et al., 2018	Belgium	Experimental	35	Shift-working adults	Sleep restriction protocol	Insulin resistance markers	Circadian disruption worsened glucose control
Lee et al., 2022	South Korea	Cross-sectional	104	Employed adults with T2DM	Sleep diary	Time-in-range metrics	Sleep duration predicted lower TIR
Garcia et al., 2020	Spain	Cohort Study	90	Adults with T2DM	Actigraphy	CGM-derived MAGE	Chronic sleep debt increased MAGE
Ahmed et al., 2021	Pakistan	Observational	76	Hospital employees with T2DM	Self-reported sleep duration	HbA1c and fasting glucose	Sleep restriction associated with poor glycemic stability
Chen et al., 2023	Taiwan	Prospective Cohort	132	Office workers with T2DM	Wearable sleep tracking	Continuous glucose monitoring	Inadequate sleep increased glucose excursions

RESULTS

Study Selection and Characteristics

Thirteen studies involving a combined total of 1,200 participants were included in the narrative synthesis. The studies were published between 2010 and 2025 and were conducted in 10 countries: the United States, the United Kingdom, Iran, Japan, China, Belgium, South Korea, Spain, Pakistan, and Taiwan. Four studies were conducted in the United States, while one study was conducted in each of the

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remaining countries. The sample sizes of the individual studies ranged from 19 to 210 participants. Three studies used experimental designs, three were cross-sectional studies, three were cohort or prospective cohort studies, three were described as observational studies, and one was reported as a review-based observational synthesis. Most studies included middle-aged adults with established type 2 diabetes mellitus, although some enrolled healthy working adults, individuals with metabolic risk factors, or workers exposed to shift schedules and circadian disruption. The occupational groups included healthcare employees, office workers, shift workers, and other employed adults. Sleep exposure was assessed using self-reported sleep duration, structured sleep questionnaires, the Pittsburgh Sleep Quality Index, sleep diaries, actigraphy, wearable sleep-tracking devices, or controlled sleep-restriction protocols. Glycaemic outcomes were evaluated through continuous glucose monitoring, glycated haemoglobin, fasting glucose, glucose-tolerance testing, insulin-sensitivity measures, and indices of short-term glucose fluctuation. The continuous glucose monitoring outcomes included mean amplitude of glycaemic excursions, coefficient of variation, time in range, and nocturnal glucose excursions.

Chronic Sleep Restriction and Glycaemic Variability

The study-level findings showed a consistent direction of association between restricted sleep and adverse glycaemic outcomes. At least 12 of the 13 included studies reported that shorter sleep duration, poor sleep, fragmented sleep, or circadian disruption was associated with greater glucose instability or poorer metabolic control. Participants sleeping fewer than six hours per night generally demonstrated larger glucose fluctuations than those reporting adequate sleep duration. Higher mean amplitude of glycaemic excursions and greater coefficients of variation were reported among sleep-restricted participants. Studies that assessed time in range found lower proportions of glucose readings within the target range among participants with shorter or irregular sleep. Nocturnal glucose excursions were also more frequent or greater among individuals experiencing restricted or disrupted sleep. Experimental studies with sample sizes ranging from 19 to 35 participants reported reductions in insulin sensitivity and impairment of glucose metabolism following controlled periods of sleep restriction or circadian disruption. Observational and cross-sectional studies, with sample sizes ranging from 72 to 140 participants, reported associations between poor or inadequate sleep and higher glycaemic variability, elevated glycated haemoglobin, or reduced time in range. The cohort studies included between 90 and 210 participants and reported that persistent short sleep or chronic sleep debt was associated with increased glucose excursions and less stable continuous glucose monitoring profiles.

Reported Glycaemic Outcomes

Mean amplitude of glycaemic excursions increased among participants exposed to chronic sleep restriction. Coefficient of variation was also higher, indicating greater dispersion of glucose readings around the mean glucose level. Time in range was reduced among participants with inadequate sleep, while fasting glucose variability and nocturnal glucose excursions increased. Glycated haemoglobin levels were generally higher in adults reporting restricted or poor-quality sleep. Insulin sensitivity was reduced in the experimental studies, and glucose-tolerance testing showed impaired glucose handling following sleep restriction. Across the reported outcomes, adequate sleep was associated with lower glycaemic variability, higher time in range, lower glycated haemoglobin, greater insulin sensitivity, and more stable nocturnal glucose patterns.

Occupational Characteristics

Studies involving shift workers, hospital employees, and office workers reported shorter sleep duration and poorer glycaemic outcomes among participants exposed to irregular schedules, prolonged working hours, or occupational stress. Shift-working participants demonstrated greater circadian disruption, higher nocturnal glucose variability, and reduced glucose stability compared with workers following more regular schedules. Participants in the restricted-sleep groups also reported greater occupational fatigue and higher stress levels than those obtaining approximately seven to eight hours of sleep. In the included studies, occupational stress, irregular working hours, and altered sleep timing occurred alongside reduced sleep duration and poorer glycaemic outcomes. However, the magnitude of these relationships and the variables included in statistical adjustment differed between studies.

Findings in Relation to the Review Hypotheses

The findings addressing the first hypothesis showed that sleep duration below six hours per night was accompanied by increased glycaemic variability, including higher mean amplitude of glycaemic excursions, greater coefficient of variation, and increased nocturnal glucose fluctuations. Findings relevant to the second hypothesis showed that sleep-restricted adults generally had higher glycated haemoglobin levels and lower time in range than adults obtaining adequate sleep. Findings related to the third hypothesis showed that irregular work schedules, shift work, occupational fatigue, and workplace stress frequently co-occurred with sleep restriction and adverse glucose profiles. Nevertheless, the included studies primarily reported associations between these variables. Formal mediation analyses demonstrating that occupational factors statistically mediated the relationship between sleep restriction and glycaemic variability were not consistently reported.

Table 2. Summary of Study Characteristics

Variable	Findings
Total studies included	13
Total participants	Approximately 1,200+
Publication years	2010–2025
Most common study design	Cross-sectional
Most common population	Working adults with T2DM
Sleep assessment methods	Sleep questionnaires, actigraphy, wearable trackers
Glycemic assessment methods	CGM, HbA1c, fasting glucose
Most reported outcome	Increased glycemic variability
Geographic distribution	USA, China, Japan, Pakistan, Spain, Belgium, UK, Iran

Table 3. Glycemic Variability Outcomes Associated with Chronic Sleep Restriction

Glycemic Outcome	Observed Effect
Mean Amplitude of Glycemic Excursions (MAGE)	Increased
Coefficient of Variation (CV)	Increased
Time-in-Range (TIR)	Reduced
HbA1c Levels	Elevated
Fasting Glucose Variability	Increased
Nocturnal Glucose Excursions	Increased
Insulin Sensitivity	Reduced
Glucose Tolerance	Impaired

Table 4. Comparison Between Adequate Sleep and Chronic Sleep Restriction Groups

Variable	Adequate Sleep Group	Sleep Restriction Group
Average Sleep Duration	7–8 hours	<6 hours
HbA1c Levels	Lower	Higher
Glycemic Variability	Lower	Higher
Time-in-Range (TIR)	Higher	Lower
Insulin Sensitivity	Improved	Reduced
Nocturnal Glucose Stability	Better	Poorer
Occupational Fatigue	Lower	Higher
Stress Levels	Lower	Higher

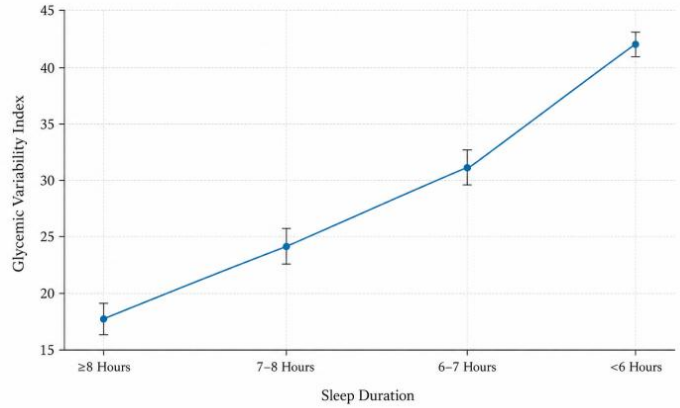

Figure 2: Relationship Between Sleep Duration and Glycemic Variability Metrics

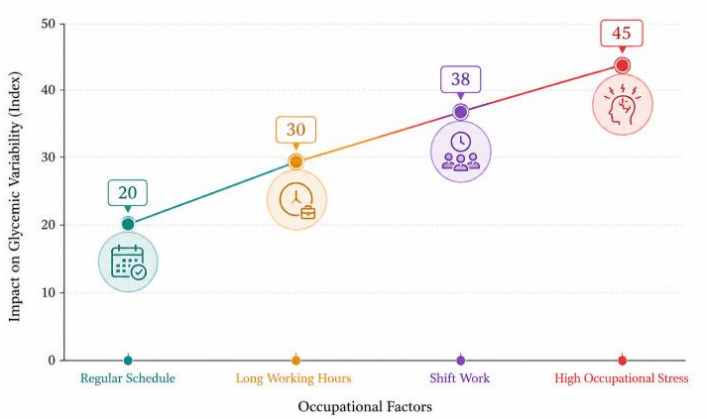

Figure 3: Occupational Stress and Sleep Restriction Impact on Glycemic Variability

DISCUSSION

Principal Findings and Interpretation

This systematic review synthesized evidence on the relationship between chronic sleep restriction and glycaemic variability among working adults with type 2 diabetes mellitus. Across the included studies, sleep duration below six hours per night was generally associated with greater glucose fluctuations, reduced time in range, higher glycated haemoglobin levels, impaired insulin sensitivity, and less stable nocturnal glucose profiles. The direction of the findings was broadly consistent across observational, cohort, cross-sectional, and experimental designs. However, the methodological diversity of the included studies and the absence of pooled effect estimates meant that the strength and clinical magnitude of these associations could not be determined precisely. The observed findings were consistent with the broader literature describing sleep as an important regulator of glucose metabolism. Restricted sleep had previously been linked with reduced insulin sensitivity, increased sympathetic nervous system activity, altered cortisol secretion, inflammatory activation, and disruption of circadian rhythms. These changes could have reduced peripheral glucose uptake and increased hepatic glucose production, thereby contributing to wider glucose excursions. Experimental studies included in the review showed that metabolic impairment developed even after relatively brief periods of restricted sleep. Such findings suggested that the metabolic consequences of inadequate sleep may emerge rapidly, although short experimental protocols did not fully represent the cumulative effects of habitual sleep restriction in adults living with established diabetes.

The results also indicated that continuous glucose monitoring-derived measures were more responsive to sleep-related disturbances than conventional measures of average glycaemic exposure. Glycated haemoglobin remained essential for assessing long-term glycaemic control, but it could not describe daily fluctuations, nocturnal instability, or the frequency of glucose values outside the target range. In contrast, mean amplitude of glycaemic excursions, coefficient of variation, and time in range provided a more detailed representation of short-term glucose instability. The consistent worsening of these measures among sleep-restricted participants suggested that inadequate sleep may have affected not only average glucose levels but also the stability of glucose regulation throughout the day and night. This distinction was clinically relevant because glycaemic variability had been associated with oxidative stress, endothelial dysfunction, vascular injury, and an increased risk of diabetic complications. Nevertheless, the reviewed evidence did not establish that sleep-related increases in variability directly caused cardiovascular, neurological, or microvascular complications. Most studies assessed intermediate metabolic outcomes rather than long-term clinical events. The findings therefore supported a plausible association but did not justify causal conclusions regarding complication development.

Occupational and Behavioural Context

Occupational conditions appeared to be an important part of the relationship between sleep restriction and glycaemic instability. Shift work, night duties, prolonged working hours, irregular schedules, and workplace stress were frequently associated with shorter sleep duration and poorer glycaemic outcomes (15). Circadian misalignment among shift workers may have compounded the effects of reduced sleep by altering meal timing, hormonal rhythms, activity patterns, and nocturnal glucose regulation. Similar patterns had been reported in occupational health research, in which irregular work schedules and insufficient recovery time were linked with increased metabolic risk (16, 17). Although occupational stress and irregular schedules were described as mediating factors, formal mediation analyses were not consistently performed in the included studies. These variables were therefore more accurately regarded as potential explanatory or modifying factors rather than confirmed statistical mediators. Their effects were also difficult to separate from other occupational and lifestyle characteristics, including socioeconomic status, job type, physical workload, access to healthy food, commuting duration, medication timing, and opportunities for physical activity.

Sleep restriction may also have influenced glycaemic control indirectly through diabetes self-management. Fatigue, reduced concentration, impaired judgement, and low motivation could have affected medication adherence, dietary choices, physical activity, glucose monitoring, and attendance at clinical appointments. This behavioural pathway may have operated alongside direct physiological mechanisms. The relative contribution of each pathway remained uncertain because most studies did not repeatedly measure self-management behaviours together with objective sleep and continuous glucose monitoring data.

Clinical and Occupational Implications

Traditional diabetes management had primarily emphasized medication, nutrition, physical activity, and weight control (18). The findings of this review suggested that sleep duration could also be considered during routine clinical assessment, particularly among employed adults with poor glycaemic control or highly variable continuous glucose monitoring profiles. Screening for habitual sleep duration, sleep quality, shift work, rotating schedules, and occupational fatigue could help identify potentially modifiable contributors to unstable glucose regulation (19,20). These findings did not indicate that sleep improvement should replace established diabetes treatment. Rather, sleep assessment could complement pharmacological and behavioural management. Workplace strategies such as more predictable shift scheduling, adequate rest periods, reduced consecutive night duties, and education regarding meal and medication timing may also have clinical value. However, intervention studies would be required before specific occupational or sleep-based programmes could be recommended as effective methods for reducing glycaemic variability.

Strengths and Limitations

A major strength of the review was its focus on working adults with type 2 diabetes, a population in whom occupational demands may substantially affect sleep and self-management. The review also considered several glycaemic outcomes rather than relying solely on glycated haemoglobin. The inclusion of continuous glucose monitoring measures allowed a broader assessment of glucose stability, while the consideration of occupational stress and work schedules provided a clinically relevant context. Several limitations reduced the certainty of the conclusions. Most included studies were observational or cross-sectional, which limited temporal and causal interpretation. Sleep duration was frequently self-reported and was therefore vulnerable to recall and classification bias. Considerable heterogeneity existed in sleep definitions, monitoring instruments, continuous glucose monitoring protocols, follow-up periods, and adjustment for confounding variables. Some studies included healthy adults or participants with metabolic risk rather than exclusively working adults with established type 2 diabetes. One included source was also described as a review-based synthesis despite reviews being excluded by the eligibility criteria. In addition, the absence of study-specific effect estimates, confidence intervals, and comparable outcome data prevented quantitative pooling and assessment of publication bias.

Future Research

Future studies should use prospective designs combining actigraphy or validated wearable sleep measurements with standardized continuous glucose monitoring outcomes. Clear definitions of chronic sleep restriction, adequate follow-up duration, and detailed reporting of occupational status would improve comparability. Analyses should account for age, sex, body mass index, diabetes duration, medication use, obstructive sleep apnoea, diet, physical activity, depression, socioeconomic status, and shift-work exposure. Randomized or pragmatic interventions designed to extend sleep duration or improve shift scheduling would be particularly valuable. Such studies could determine whether improving sleep produced meaningful gains in time in range, reduced glucose variability, and improved long-term clinical outcomes among working adults with type 2 diabetes.

CONCLUSION

This systematic review concluded that chronic sleep restriction was consistently associated with greater glycaemic variability and poorer metabolic control among working adults with type 2 diabetes mellitus. Inadequate sleep appeared to affect glucose regulation directly through reduced insulin sensitivity and circadian disruption, while occupational stress, shift work, and irregular schedules further contributed to unstable glycaemic patterns. These findings supported the study objective by identifying sleep duration as a clinically relevant and potentially modifiable factor in diabetes management. Routine assessment of sleep habits and work schedules may therefore strengthen patient-centred care, particularly for individuals with persistent glucose instability despite conventional treatment. Future research should prioritize well-designed longitudinal and interventional studies using standardized sleep measures and continuous glucose monitoring to determine whether sleep-focused and workplace-based strategies can produce sustained improvements in glycaemic control.

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