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Hubungan Durasi Tidur Dengan Kadar Hba1c Pada Pasien DM Tipe 2.

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ABSTRACT

Background and Purpose:
Sleep is essential for regulating our metabolism, and not getting enough or getting too much sleep has been linked to problems with how our body manages glucose. However, the exact connection between sleep length and blood sugar control, measured by glycated hemoglobin (HbA1c), in people with Type 2 Diabetes (T2DM) isn't completely clear. This review looks at recent studies from 2020 to 2025 to better understand how sleep duration affects HbA1c levels in adults with T2DM.
Methods:
We searched databases like PubMed, Google Scholar, and ScienceDirect for studies published between 2020 and 2025 that examined the impact of sleep duration (short, normal, or long) on HbA1c levels in adults with T2DM. Both cross-sectional and cohort studies were included. Ten relevant articles were chosen and reviewed using the PICO framework.
Results:
Most research found a U-shaped relationship: both sleeping too little (less than 6 hours) and too much (more than 9 hours) were linked to higher HbA1c levels compared to getting a normal amount of sleep (7–8 hours). Short sleep was often connected to poorer sleep quality, higher resistance to insulin, and worse blood sugar control. Some studies also suggested that improving sleep duration and quality can help lower HbA1c levels a little.
Conclusion:
Getting either too little or too much sleep is connected to poorer blood sugar control in people with T2DM. Regularly checking and improving sleep habits should be part of managing diabetes effectively.

Keywords ***Sleep; Sleep Duration; Hemoglobin A, Glycosylated; Diabetes Mellitus, Type 2; Blood Glucose***

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the major health problems worldwide because the number of sufferers continues to grow. This disease is the leading cause of various serious complications, affecting both small and large blood vessels, resulting in a high mortality and morbidity rate (Pan C, 2025). Controlling blood sugar levels over the long term, which is usually measured through HbA1c, is very important to reduce the risk of complications such as kidney, eye, and heart disease (Boye KS, 2022)
In managing T2DM, we have focused heavily on diet, exercise, and medication. However, recently attention has also begun to shift to the importance of sleep, both in terms of duration and quality, in regulating blood sugar metabolism. Several studies show that sleeping too little or even too long can affect the body's ability to process sugar, lack of sleep can disrupt the balance of hormones that regulate the body's metabolism. This condition reduces the body's sensitivity to insulin. As a result, blood sugar levels become difficult to control in people with type 2 diabetes mellitus (Singh T, 2022). For example, a meta-analysis found a U-shaped relationship between sleep duration and HbA1c levels: sleeping less than 6 hours or more than 9 hours was associated with higher HbA1c levels compared to sleeping a normal amount (Lee SWH, 2017).

More specifically, a study conducted by Tan and his team involving more than 13,000 T2DM patients found that sleeping too long (9 hours or more) and a high risk of obstructive sleep apnea (OSA) were both associated with slightly higher HbA1c levels compared to those who slept normally (7-8 hours).

This association remained significant after accounting for various other factors that could influence the results (Tan X., 2020). Similarly, actigraphy analysis of 172 DMT2 patients showed that sleep duration variability ($\beta = 0.239$; $p = 0.002$) and total sleep duration (U-shaped relationship) were significantly associated with HbA1c (Brouwer A., 2020).

However, there are several limitations in previous studies. Many studies only rely on participants' reports of their sleep patterns without using objective measuring instruments. Some also do not fully control for factors that could influence the results, such as obesity, duration of diabetes, medications used, or other sleep disorders such as obstructive sleep apnea (OSA) (Aguayo GA e. a., 2022). In addition, most research has not focused much on specific groups, such as adult women aged 30-65 or the population in Indonesia. This condition shows that there is still room for more structured and up-to-date literature reviews (Ding C, 2019).
Therefore, this literature review aims to conduct a more comprehensive and up-to-date assessment of the relationship between sleep duration and HbA1c levels in T2DM patients, by critically taking into account differences in sleep measurement methodologies and diverse population characteristics, which is expected to provide clearer clinical guidance and inform future research directions. (Aguayo GA & Group, 2022).

Objective
This study sets out to systematically explore the recent scientific landscape (2020–2025) to better understand the often-overlooked connection between how long T2DM patients sleep and their long-term sugar control (HbA1c). Our two main goals are to critically assess the real-world clinical impact of sleep duration on managing diabetes and, most importantly, to pinpoint practical, modifiable sleep habits that clinicians can immediately target. By synthesizing these current findings, we hope to move beyond medication and provide clear, actionable guidance on utilizing sleep as a powerful and accessible tool in the holistic management of Type 2 Diabetes..

METHODS
Ethical Considerations
This study is a literature review that utilized secondary data from previously published research articles. As it did not involve direct participation of human subjects, ethical approval or informed consent was not required. However, all review procedures were conducted in accordance with national and international research ethics principles, emphasizing data accuracy, transparency, and the scientific integrity of the authors.

Literature Search Strategy
A systematic literature search was performed using major electronic databases, including PubMed (U.S. National Library of Medicine, Bethesda, MD, USA), Scopus (Elsevier, Amsterdam, Netherlands), ScienceDirect (Elsevier, Amsterdam, Netherlands), and Google Scholar (Google LLC, Mountain View, CA, USA).
The search covered publications from January 2020 to September 2025, using combinations of the following keywords: *"sleep duration," "sleep time," or "sleep pattern"* combined with *"HbA1c," "glycated hemoglobin," or "glycemic control"* and *"type 2 diabetes mellitus"* or *"T2DM"*, employing Boolean operators (AND and OR).
The search was limited to articles published in English or Indonesian. The entire identification and screening process adhered to the PRISMA (Preferred Reporting Items **for Systematic** Reviews and Meta-Analyses) guidelines to ensure a transparent and structured review process.

Inclusion and Exclusion Criteria
Articles were included if they met the following criteria:
1. Conducted on adult participants (≥18 years) diagnosed with type 2 diabetes mellitus (T2DM).
2. Reported both sleep duration (in hours) and HbA1c levels as primary variables.
3. Employed a cross-sectional, cohort, or interventional study design.

4. Published in peer-reviewed journals between 2020 and 2025, presenting extractable quantitative data (e.g., mean, standard deviation, or effect size).

Studies were excluded if they were reviews, editorials, case reports, or lacked clear data on sleep duration and HbA1c. Research involving patients with type 1 diabetes, gestational diabetes, or severe chronic diseases such as end-stage renal disease were also excluded from analysis.

Data Extraction

Data extraction was independently performed by two reviewers using a standardized data collection form. Extracted information included the authors' names, year of publication, study country, study design, participant characteristics (age, sex, and sample size), sleep duration categories, HbA1c measurement methods, and main findings (mean values, standard deviations, correlations, or effect sizes).

Any discrepancies between the reviewers were resolved through discussion and consensus to ensure the validity and reliability of the extracted data.

Quality Assessment

The methodological quality of each included study was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist. This instrument evaluates study design clarity, measurement accuracy, and potential sources of bias. Only studies rated as moderate to high quality were included in the final analysis to maintain the reliability and credibility of the review findings.

Data Synthesis and Analysis

The collected data were synthesized descriptively and narratively to critically examine the relationship between sleep duration and HbA1C levels in T2DM patients, grouping findings based on key methodological differences (e.g., objective vs. subjective sleep measurement). Descriptive statistical analyses for summarizing the included studies were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). In addition to considering the p-value, this study also critically evaluated the effect size (e.g., Beta coefficients, Odds Ratios) and confidence intervals (Cis) reported by the original authors to illustrate the strength and precision of the relationships between variables, highlighting any significant heterogeneity or inconsistencies across the findings. All statistical terms, abbreviations, and symbols were clearly defined to ensure clarity and accessibility for readers from diverse academic backgrounds.

RESULTS

No.	Study Fo Study Focus / Area of Evidencecus / Area of Evidence	Specific Findings on Sleep and HbA1c/T2DM Risk	Explanation and Clinical Implication	Source (Representative Studies)
1.	Sleep duration and diet patterns in T2DM risk	Sleeping 5 h/day: HR = 1.16; 3–4 h/day: HR = 1.41; a healthy diet reduced T2DM risk (HR = 0.75). No interaction between diet and sleep.	Short sleep (<6 h) increases the risk of developing T2DM even in individuals with healthy eating habits.	Nôga et al., 2024, JAMA Network Open
2.	Sleep duration and obesity moderation	Individuals sleeping ≤5 h/night had a higher T2DM risk (HR = 1.17, 95% CI: 1.02–1.33), especially among non-obese, men, and younger participants.	The association between short sleep and diabetes is more pronounced in non-obese and younger adults.	Lee et al., 2023, Endocrinol Metab
3.	Objectively measured sleep duration and diabetes status	U-shaped relationship: both 5 h (OR = 2.6) and 12 h (OR = 1.8) of	Both short and long sleep durations are independently	Albers et al., 2023, Sleep Health

		sleep increased T2DM odds compared to 8 h.	associated with higher T2DM risk regardless of lifestyle factors.	
4.	Sleep duration, insomnia, and sleep apnea in T2DM	Long sleep (≥9 h) and high OSA risk were linked to higher HbA1c (+0.10% and +0.07%), while short sleep ≤6 h showed weak association.	Long sleep and sleep apnea contribute to poorer glycemic control among patients with T2DM.	Tan & Benedict, 2020, BMJ Open Diabetes Res Care
5.	Sleep variability and glycemic control	Sleep duration variability and total sleep time were significantly correlated with HbA1c (R^2 = 4.9% and 4.3%).	Irregular and insufficient sleep may worsen glycemic control in T2DM patients.	Brouwer et al., 2020, Diabetes Care
6.	Sleep quality and glucose control	44.8% had poor sleep quality; those with poor glycemic control had significantly higher sleep disturbance ($p < 0.001$).	Poor sleep quality is negatively correlated with glycemic control and should be targeted in diabetes care.	Borzouei et al., 2024, J Fam Med Prim Care
7.	Sleep duration and dietary/lifestyle factors	Determinants of HbA1c differed by sleep category: <7 h – age, stress; 7–9 h – energy/protein intake; >9 h – alcohol use and health checkups.	Sleep duration affects which factors most influence HbA1c; personalized diabetes management should consider sleep habits.	Kwon et al., 2025, Diabetology (MDPI)
8.	Sleep as a lifestyle component in diabetes management	ADA/EASD 2024 guidelines include sleep as a lifestyle behavior alongside diet and physical activity.	Sleep should be routinely assessed and optimized in clinical management of T2DM.	Henson et al., 2024, Diabetes Care
9.	Sleep duration, obesity, and diabetes pathophysiology	Cohort evidence shows short sleep increases risk of obesity and T2DM through insulin resistance and energy imbalance.	Short sleep is an independent metabolic risk factor for T2DM mediated by obesity and hormonal dysregulation.	Antza et al., 2021, J Endocrinol

The synthesis of recent literature (2020–2025) strongly confirms that sleep is an independent and multifaceted determinant of glycemic control in Type 2 Diabetes Mellitus (T2DM) patients. The evidence extends far beyond mere duration, highlighting the necessity of a comprehensive sleep assessment in clinical practice.

1. Beyond Sleep Duration: Quality and Regularity are Key

While cohort studies consistently confirm that extreme short sleep ($\leq 6\ hours$) is an independent modifiable risk factor for both Type 2 Diabetes Mellitus (T2DM) onset (Nôga D.A., 2024) (Lee D.Y., 2023) and poorer HbA1c control, the cross-sectional data introduce nuances often missed by duration

alone. Studies using objective measures and comprehensive questionnaires found that sleep regularity (variability in sleep/wake times) and insomnia symptoms are individually among the most robust predictors of elevated HbA1c (Brouwer A., 2020). This suggests that inconsistency in sleep timing (social jet lag) and subjective poor quality are perhaps more detrimental to blood sugar management than just the total hours slept.

2. The U-Shaped Relationship and Underlying Pathology

The evidence supporting a U-shaped curve for sleep duration and Type 2 Diabetes (T2D) risk confirms that both short and excessively long sleep ($> 9\,hours$) are detrimental (Albers J.D., 2023). Mechanistically, experimental studies provide a clear biological basis: acute sleep restriction directly induces peripheral and hepatic insulin resistance and compromises β-cell function (Antza C., 2021). Furthermore, the frequent co-existence of Obstructive Sleep Apnea (OSA) in Type 2 Diabetes Mellitus (T2DM) patients also significantly contributes to poor HbA1c, underscoring the need for simultaneous assessment of duration, quality, and specific sleep disorders (Tan X., 2020).

3. Clinical Implications: Modifiable Targets

Collectively, these findings mandate the integration of sleep assessment into standard Type 2 Diabetes Mellitus (T2DM) care. Clinicians must move beyond asking "How many hours did you sleep?" and target three modifiable pillars ((Henson J., 2024):

- Optimal Duration: Aim for a target of 7–9 hours per night.
- Regularity: Counsel patients on consistent sleep and wake times to reduce "sleep variability" and "social jet lag."
- Quality: Screen and manage symptoms of insomnia and OSA, which are strongly linked to the failure to achieve glycemic targets (Borzouei S., 2024).

By addressing these holistic sleep metrics, personalized, non-pharmacological interventions can serve as a potent adjunct therapy to improve Type 2 Diabetes Mellitus (T2DM) outcomes.

Abbreviations

T2DM (Type 2 Diabetes Mellitus), T2D (Type 2 Diabetes), HbA1c (Glycated Hemoglobin A1c), OSA (Obstructive Sleep Apnea), β-cell (Beta-cell), PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), JBI (Joanna Briggs Institute), PSG (Polysomnography).

DISCUSSION

This review highlights a consistent pattern showing that both short and long sleep durations are linked to poorer glycemic control among people with type 2 diabetes mellitus (T2DM). These findings align with the study's main objective—to understand how sleep duration relates to HbA1c levels and to identify sleep-related factors that might be modified as part of diabetes management (Gozashti MH, 2016). Collectively, the evidence establishes sleep not merely as a biological necessity but as a meaningful and modifiable behavioral factor critical to diabetes prevention and effective. (Nôga D.A., 2024) (Kwon M., 2025).

A clear U-shaped relationship was observed across multiple studies, where both insufficient and excessive sleep were associated with unfavorable HbA1c profiles (Albers J.D., 2023) (Brouwer A., 2020). People sleeping less than six hours per night generally had higher HbA1c levels and a greater risk of developing diabetes compared to those with normal sleep duration. On the other hand, individuals who slept more than nine hours often had similarly poor glycemic outcomes (Whitaker K.M., 2018). The biological mechanisms behind these patterns are multifactorial. Sleep deprivation can increase sympathetic nervous system activity, elevate cortisol levels, and reduce insulin sensitivity, leading to higher blood glucose (Antza C., 2021) (Henson J., 2024). Conversely, longer sleep may be a marker of other health problems—such as depression, fatigue, or obstructive sleep apnea—that indirectly affect glucose metabolism (Tan X., 2020). Thus, while short sleep is mechanistically causative, long sleep is often a valuable clinical red flag for unmanaged comorbidities.

Sleep quality and regularity also play crucial roles in glucose regulation. Studies by (Brouwer A., 2020) and (Borzouei S., 2024) found that individuals with poor or inconsistent sleep patterns had higher HbA1c levels, regardless of sleep duration. (Henson J., 2024) emphasized that both sleep quality and duration should be considered in clinical practice, as irregular sleep may disrupt circadian rhythms and insulin

sensitivity. This suggests that circadian alignment must be a core component of future sleep interventions, complementing the focus on duration. These findings underscore that improving the *quality* of sleep may be just as important as adjusting the *amount* of sleep (Zhao, 2021).

Lifestyle and psychosocial factors further influence these associations (Kwon M., 2025) reported that stress and alcohol consumption were particularly relevant among short sleepers, while dietary factors and education level played a stronger role among those with normal sleep duration. Similarly, (Nôga D.A., 2024) found that short sleep increased diabetes risk even among individuals who followed a healthy diet, suggesting that suggesting a crucial interactive relationship where the benefits of a healthy diet may be diminished in the presence of sleep deficiency. Such findings highlight the importance of a holistic approach to diabetes care that includes behavioral, psychological, and lifestyle components (Juanamasta IG, 2021).

Still, some inconsistencies exist. Not all studies controlled for confounding variables such as obesity, medication use, and diabetes duration (Lee D.Y., 2023) (Albers J.D., 2023). Moreover, many relied on self-reported sleep duration rather than objective tools like actigraphy or polysomnography (Antza C., 2021), which can lead to misclassification or recall bias. Future research must prioritize the use of objective sleep measurement tools (actigraphy or PSG) in longitudinal, interventional trials to move beyond correlational findings and definitively establish causality and efficacy of sleep interventions.

In summary, the reviewed literature supports the view that sleep duration and quality are meaningful predictors of glycemic control in T2DM (Zhu B., 2017). Both too little and too much sleep can disrupt glucose metabolism, while irregular or poor-quality sleep may further worsen metabolic outcomes (Shibabaw Y.Y., 2023). Integrating sleep assessment into diabetes management could help clinicians identify high-risk patients and provide more individualized treatment (Liu H., 2025). Beyond pharmacological therapy, improving sleep behavior offers a simple, low-cost strategy to enhance glycemic outcomes and overall well-being (Henson J., 2024).

CONCLUSION

Advancing the Field and Addressing Objectives

This systematic review of the literature firmly establishes that sleep duration must be recognized as a substantial and modifiable independent risk factor in the pathogenesis of Type 2 Diabetes Mellitus (T2DM). This finding significantly advances the fields of endocrinology and public health by demonstrating that habitual short sleep duration (hours/day) is robustly associated with an increased incidence of T2DM, even in individuals adhering to otherwise healthy dietary patterns. This provides clear scientific justification: protective dietary behaviors may be insufficient to counteract the metabolic risk induced by chronic sleep deprivation.

The relationship between sleep duration and T2DM risk follows a U-shaped curve model, where durations outside the optimal 7–8 hours/day range (i.e., both hours and hours) independently heighten metabolic vulnerability. Furthermore, for individuals with established T2DM, variability or inconsistency in daily sleep duration is demonstrated to be the strongest predictor of compromised glycemic control (elevated HbA1c).

Clinical Applications and Practice Extensions

These conclusions mandate a paradigm shift in clinical guidelines, positioning sleep as a core component in T2DM prevention and management, on par with diet and exercise. Clinical implications include the necessity for routine sleep screening and the incorporation of objective measurement tools (such as actigraphy) in practice settings to facilitate personalized interventions.

IMPLICATION

Theoretical Contribution and Future Research Directions

The findings contribute theoretically by positioning sleep as a fundamental regulator of metabolic homeostasis, rather than a mere behavioral correlate. This calls for mechanistic studies on central nervous system regulation of insulin sensitivity.

Implications for Practice:

The development of clinical interventions must now incorporate detailed sleep strategies. Healthcare professionals are encouraged to actively address sleep hygiene and the inconsistency of sleep schedules, particularly in high-risk populations identified through sleep screening.

Extensions/Future Research Directions:

To establish definitive causality and refine mechanistic understanding, future studies must prioritize:

1. Randomized Controlled Intervention Trials (RCTs): To determine if interventions aimed at sleep extension in habitual short sleepers can causally reduce T2DM incidence.
2. Integration of Objective Measures: Replacing reliance on self-report with objective data (e.g., actigraphy, sleep lab data) in large cohort studies to accurately account for sleep quality and often-missed comorbid sleep disorders.

STRENGTHS AND LIMITATION

Study Strengths

The epidemiological studies underpinning this review are characterized by substantial methodological strengths:

- Large, Long-Term Prospective Cohorts: The utilization of large population cohorts (e.g., UK Biobank) with long median follow-up periods (e.g., years) provides high statistical power and strong external validity for assessing long-term risk.
- Robust Analysis: Analyses employing Cox proportional hazards models included extensive adjustment for a broad range of established confounding variables, confirming the independent nature of the observed associations.

Study Limitations

The following inherent limitations should be considered when interpreting the findings:

- Subjective Data Limitations: The primary reliance on self-reported measures for sleep duration and dietary habits introduces the risk of information bias and recall bias, potentially leading to outcome misclassification.
- Lack of Sleep Disorder Accounting: Most studies failed to comprehensively evaluate or adjust for the presence of clinically significant comorbid sleep disorders (e.g., Obstructive Sleep Apnea or Insomnia), which are known, strong T2DM risk factors.
- Limited Generalizability: Despite the large sample size, the specific nature of the cohorts studied may constrain the ability to generalize findings directly across all global populations.

Conflict of Interest

The authors declare no conflicts of interest related to this work.

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Declaration of Using AI

AI tools were used only for language refinement; all content and interpretations are the authors' own.

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