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Association between night shift work and the risk of type 2 diabetes mellitus: a cohort-based meta-analysis

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Abstract

Background The impact of night shift work on the incidence of type 2 diabetes mellitus (T2DM) is not well understood. This meta-analysis assesses the association between night shift work and the risk of developing T2DM and explores this relationship across various subgroups.

Methods We systematically searched PubMed, Web of Science, EBSCO, and the Cochrane Library from their inception until February 2024. We employed hazard ratios (HR) and 95% confidence intervals (95%CI) to quantify the association between night shift work and T2DM risk.

Results Our analysis synthesized data from 9 articles encompassing 10 cohort studies. Overall, night shift workers exhibited a 30% increased incidence of T2DM compared to their daytime counterparts (HR = 1.30, 95% CI: [1.18, 1.43], $P < 0.001$). Among females, night shift workers had a higher incidence of T2DM (HR = 1.28, 95% CI: [1.16, 1.41]); however, in males, the association was not statistically significant (95% CI: [0.89, 2.63]). For individuals with a body mass index (BMI) > 30 kg/m^2, night shift work was associated with an increased T2DM risk (HR = 1.14, $P = 0.007$), whereas there was no significant association for those with a BMI ≤ 30 kg/m^2 ($P = 0.255$). Further, the risk of T2DM increased with longer durations of night shift work; workers with more than 10 years of night shift work faced a higher T2DM risk than those with 10 years or fewer (HR for > 10 years = 1.17, 95% CI: [1.10, 1.24]; HR for ≤ 10 years = 1.06, 95% CI: [1.03, 1.10]).

Conclusion Findings suggest potential link between night shift work and T2DM risk. Longer durations of night shift work may increase the risk of T2DM. There may be gender differences (greater harm in women, but the male sample size is small) and obesity differences.

Keywords Night shift work, Type 2 diabetes mellitus, Gender, BMI, Risk, Meta-analysis

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Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by elevated blood sugar levels, insulin resistance, or deficiency. It is closely linked to various comorbidities including atherosclerosis, cardiovascular disease, myocardial infarction, heart failure, and stroke [1, 2]. As the global population ages and expands, the prevalence of T2DM has dramatically increased, the global age-standardized total diabetes prevalence increased by 90.5% from 1990 to 2021 [3]. The number of affected people rose from 108 million in 1980 to 422 million in 2014 [4]. In 2021, there were approximately 529 million T2DM patients. As early as 2017, diabetes had already ranked as the ninth - leading cause of death. It is even predicted that more than 1.31 billion people will have T2DM in 2050 [3]. The medical expenses of T2DM patients without complications are approximately 3.2 times the average medical expenditure, and those of patients with microvascular and macrovascular complications can be up to 9 times the average [5]. T2DM represents a substantial challenge to public health security. Beyond genetic factors, the potential risk factors for T2DM include obesity, dietary habits, occupation, lifestyle, and psychological stress. Conversely, intake of 66 g of fruits and/or vegetables per day may reduce the risk of T2DM by a quarter over time [6].

Numerous studies have identified night shift work as a contributing factor to adverse health outcomes, such as increased incidences of T2DM, hypertension, and dyslipidemia [7, 8]. Over the past decade, several meta-analyses have examined the link between night shift work and T2DM. A 2015 meta-analysis found that shift work significantly elevates the risk of T2DM, particularly among females compared to males [9]. However, this study may have overestimated the impact of night shift work on T2DM risk, as it included some participants categorized as prediabetic. A more recent study in 2020 confirmed the positive association between shift work and T2DM risk but noted that less than half of the included studies were cross-sectional, offering weaker evidence [10]. In response to these findings, our current study exclusively focuses on published cohort studies to further investigate the association between night shift work and the risk of T2DM.

Methods

Search Strategy

This systematic review and meta-analysis adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [11]. The review was registered with PROSPERO (ID: CRD42024520037). We searched the electronic databases PubMed, Web of Science, EBSCO, and the Cochrane Library from inception through February 2024. Search terms used included MeSH terms "Shift Work Schedule" and "Diabetes Mellitus, Type 2", supplemented with keywords "Night shift", "Shift work", and "T2DM". We also manually screened references to identify relevant studies. Two researchers independently screened all retrieved literature based on pre-defined criteria, with discrepancies resolved through consensus.

Inclusion and exclusion criteria

Inclusion criteria encompassed studies where: (1) participants did not have T2DM, (2) the exposure factor was night shift work (night shift work and shift work that includes night shift work), (3) the control condition was non-night shift work, and (4) the study was an English-language cohort study examining the association between night shift work and T2DM.

Exclusion criteria included: (1) studies where data could not be statistically analyzed, and (2) studies originating from the same cohort, selecting only the most recent or comprehensive articles for inclusion.

Data extraction

Data were extracted by two independent researchers using a standardized form. Extracted data included authors, publication year, country, sample size, participant age and gender, body mass index (BMI), profession, study design, source of population, follow-up duration, adjustment parameters, duration of night shifts, and assessments of prediabetes and T2DM.

Quality Assessment

The quality of cohort studies was assessed independently by two reviewers using the Newcastle-Ottawa Scale (NOS). Four stars were allocated to cohort selection criteria, three to outcome assessment, and two to comparability between groups. Studies were then categorized as low (0–3), moderate (4–6), or high (7–9) quality. Only high-quality studies were included. Any disagreements were resolved by a third investigator.

Statistical analysis

The association between night shift work and T2DM was analysed using hazard ratios (HR) and 95% confidence intervals (95%CI). Given potential heterogeneity due to factors such as shift intensity, dietary habits, ethnicity, and physical activity, a random effects model was employed to calculate weights. Heterogeneity among studies was assessed using the Chi-square and I^2 tests, with $p<0.05$ and $I^2 \geq 50\%$ indicating significant heterogeneity. Original studies with large sample sizes (the results are more reliable) are often given higher weights. The combined results are represented by forest plots. Publication bias was evaluated using Begg's test. Sensitivity analyses were conducted using the leave-one-out

method. Statistical analyses were performed using Stata 12.0, employing a two-sided hypothesis test with significance set at $p<0.05$.

Results

Literature search

The search and selection processes are depicted in Fig. 1. Initially, 4170 records were retrieved from electronic databases. An additional two studies were included through manual searches of reference lists from relevant studies. After duplicates were removed, 3454 articles remained. Based on title and abstract screening, 3390 articles were excluded. Following a full-text review of 64 articles against the selection criteria, 55 were excluded for the following reasons: non-cohort study design ($n=15$), failure to meet inclusion criteria ($n=26$), lack of available data ($n=11$), and overlapping reports on the same participants ($n=3$). Ultimately, 9 articles, comprising 10 cohort studies, were included in the meta-analysis [12–20].

Study characteristics

The 9 included articles, published between 1999 and 2021, consisted of one retrospective and nine prospective cohort studies. Geographically, four studies were conducted in Eastern countries and six in Western countries. The detailed characteristics of the included cohort studies are presented in Table 1.

Assessment of T2DM

T2DM was primarily assessed through fasting plasma glucose levels (FPG)≥126 mg/dL, physician diagnoses, or medication usage. Adjusted parameters commonly included age, gender, marital status, BMI, ethnicity, living status (alone or with others), family history of diabetes,

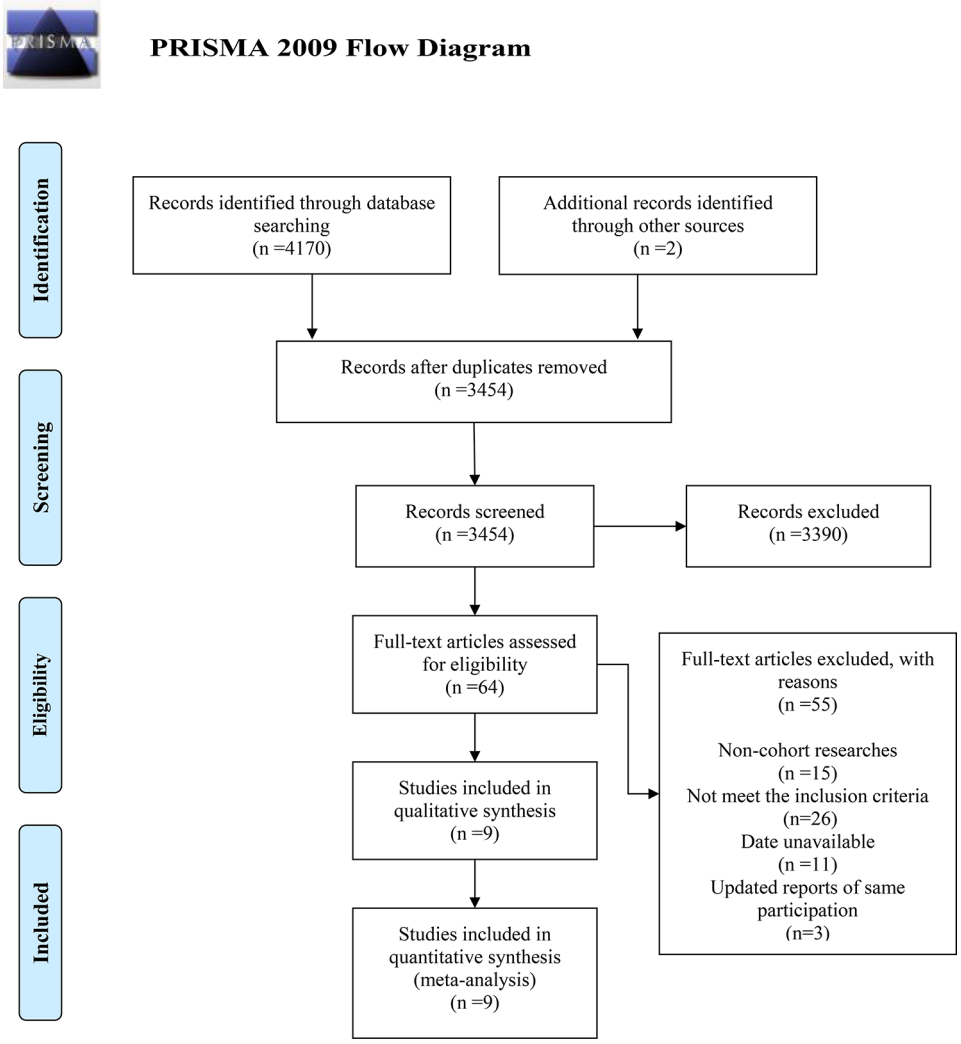

Fig. 1 Flow diagram of the selection process

Table 1 Characteristics of included observational studies in the meta-analysis

Author	Year	Country	Cohort	No. of participant	Follow-up time (year)	Professions	The type of work shift	Adjust parameters	Study design
Osaki, Y.	2021	Japan	J-ECOH	17,628	13	Workers	Shift work	age, gender, marital status, hypertension, dyslipidemia, family history of diabetes, sedentary work, over time working, job position, alcohol, smoking, sleep duration, physical activity, BMI	Prospective
Silva-Costa, A.	2020	Brazill	ELSA-Brasil	8656	12	Civil servants	Night shifts (≥ 5 consecutive hours of night work [22:00–05:00 h] at least four times per month)	age, education, hours of work, BMI, physical activity	Prospective
Hanprathet, N.	2019	Thailand	NA	5947	7	Workers	Current shift workers (did permanent night shifts only for at least three night shifts per month or; who rotated between two or three shifts with at least three night shifts per month until the baseline year)	age, marital status, family history of diabetes, BMI, hypertension, DBP, FPG, WBC, TG, HDL-C, WC, education	Retrospective
Shan, Z.	2018	United States	Nurses' Health Study	55,324	24	Nurses	Rotating night shift work	age, calendar year, ethnicity, BMI, marital status, living status, family history of diabetes, menopausal status, oral contraceptive, alcohol, energy intake, smoking, physical activity, AHEI	Prospective
Shan, Z.	2018	United States	Nurses' Health Study II	88,086	22	Nurses	Rotating night shift work	age, marital status, calendar year, BMI, ethnicity, living status, family history of diabetes, menopausal status, oral contraceptive, alcohol, energy intake, smoking, physical activity, AHEI	Prospective
Bannai, A.	2016	Japan	NA	3195	6	Civil servants	Shift work	age, marital status, FPG, family history of diabetes, education, job position	Prospective
Hansen, Anne B.	2016	Denmark	The Danish Nurse Cohort	19,492	19	Nurses	Night shifts	age, smoking, physical activity, alcohol, fatty meat intake, marital status, job position, acute myocardial infarction, hypertension, fruit and vegetables intake, BMI	Prospective
Vimalananda, V. G.	2015	USA	BWHS	28,041	8	NA	Night shift work	age, questionnaire cycle, BMI, family history of diabetes, education, neighborhood socioeconomic status, vigorous activity levels, smoking, alcohol, energy intake, diet, coffee, decaffeinated coffee, soda, diet soda	Prospective
Poulsen, K.	2014	Denmark	NA	7305	7	Health care workers	Evening/night shift work	health, work, lifestyle	Prospective
Kawakami, N.	1999	Japan	NA	2194	8	Industrial workers	Rotating shift workers engaged in two or three shift work schedules including night shift, with a weekly clockwise rotation	age, BMI, education, alcohol, smoking, physical activity, family history of diabetes	Prospective

J-ECOH: Japan Epidemiology Collaboration on Occupational Health Study; BWHS: Black Women's Health Study; No.: number; NA: not available; BMI: body mass index; DBP: diastolic blood pressure; WBC: white blood cell; TG: triglyceride; HDL-C: high density lipoprotein cholesterol; WC: waist circumference; AHEI: Alternate Healthy Eating Index score; FPG: fasting plasma glucose

alcohol consumption, and smoking habits. These details are further elaborated in Supplementary Table 1.

Bias risk assessment

The Newcastle-Ottawa Scale (NOS) was employed to objectively assess the quality of the included observational cohort studies. The evaluations revealed that four cohort studies scored 9 points, four scored 8 points, and two scored 7 points. Detailed bias risk assessments are documented in Supplementary Table 2.

Association between Night Shift Work and T2DM

The meta-analysis demonstrated that night shift workers exhibit a higher incidence rate of T2DM compared to non-night shift workers (HR=1.30, 95%CI: [1.18, 1.43], $P<0.001$, $I^2=57.6\%$). Further details are presented in Fig. 2. All p-values in texts, tables, and captions are derived from HR analysis and all p-values in pictures are from heterogeneity analysis.

Subgroup analysis of the association between night shift work and risk of T2DM

Gender association

In the female subgroup, night shift work was associated with a higher incidence of T2DM than the non-night shift work group (HR=1.28, 95%CI: [1.16, 1.41], $P<0.001$, $I^2=57.8\%$). In contrast, no significant association was observed in the male subgroup (HR=1.53, 95%CI: [0.89, 2.63], $P=0.128$, $I^2=45.8\%$). Further details can be found in Fig. 3.

Occupational association

Both medical and non-medical workers exposed to night shifts exhibited a higher risk of T2DM compared to those who were not exposed to night shifts (medical workers: HR=1.33, $P<0.001$; non-medical workers: HR=1.27, $P=0.007$), as detailed in Table 2.

BMI-based association

For participants with a BMI≤30 kg/m^2, no significant association was found between night shift work and T2DM (HR=1.34, 95%CI: [0.81, 2.22], $P=0.255$, $I^2=87.4\%$). However, for those with a BMI>30 kg/m^2, night shift workers had a higher incidence of T2DM compared to non-night shift workers (HR=1.14, 95%CI: [1.04, 1.25], $P=0.007$, $I^2=0.0\%$), as shown in Fig. 4.

Duration of night shift work

Participants with ≤5 years of night shift work had an increased risk of T2DM compared to those with no night shift work (HR=1.05, 95%CI: [1.01, 1.10]), which was more pronounced in those with >5 years of exposure (HR=1.13, 95%CI: [1.09, 1.18]). The risks associated with ≤10 years and >10 years of night shift work were similarly elevated (≤10 years: HR=1.06, 95%CI: [1.03, 1.10]; >10 years: HR=1.17, 95%CI: [1.10, 1.24]). These findings are detailed in Table 2; Fig. 5.

Follow-up time

The risk of T2DM was higher in night shift workers compared to non-night shift workers regardless of the follow-up time (≤10 years: HR=1.43, 95%CI: [1.09, 1.86],

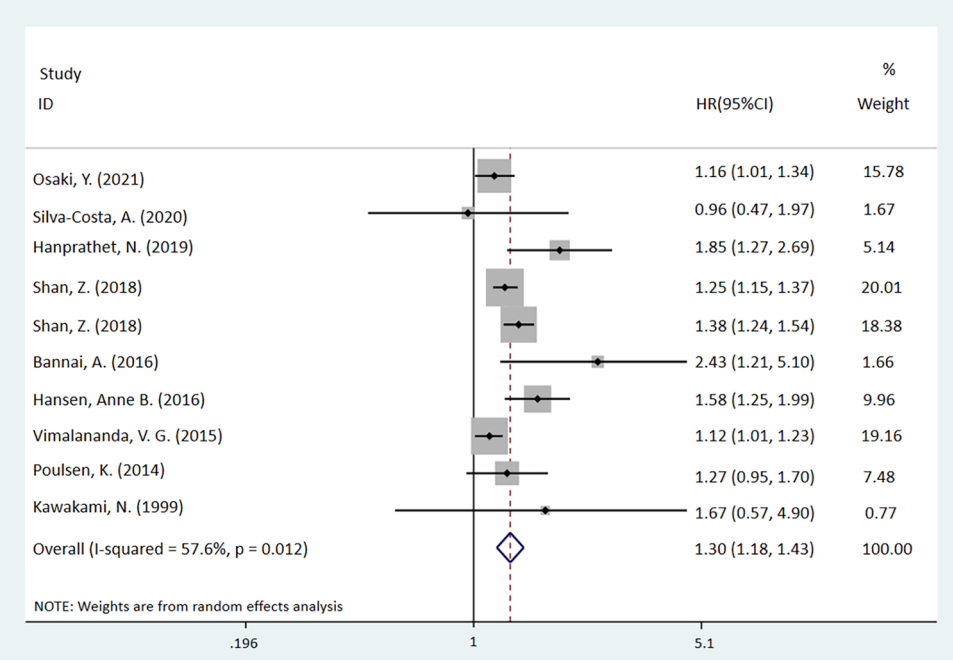

Fig. 2 Forest plot of a meta-analysis assessing the association between night shift work and the risk of T2DM in all participants ($p<0.001$)

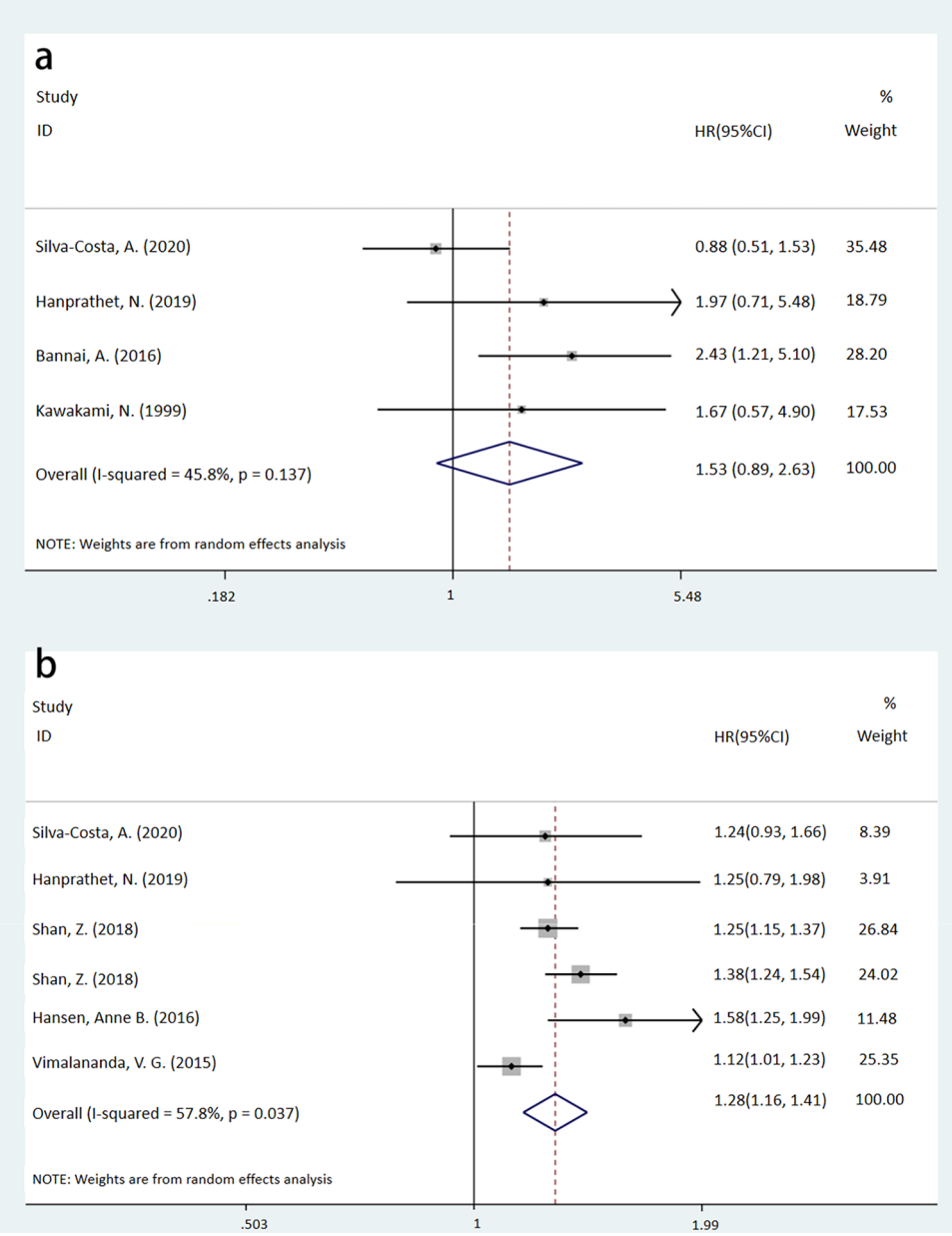

Fig. 3 Forest plots of a meta-analysis assessing the association between night shift work and the risk of T2DM in sex-specific subgroups (a: male, $p=0.128$; b: female, $p<0.001$)

$P=0.009$, $I^2=64.0\%$; >10 years: HR=1.30, 95%CI: [1.18, 1.43], $P<0.001$, $I^2=48.2\%$), with details in Table 2.

Age-specific association

For individuals≤60 years old, the incidence of T2DM was significantly higher among night shift workers (HR=1.35, 95%CI: [1.20, 1.52], $P<0.001$, $I^2=44.6\%$), as reported in Table 2.

Publication bias and sensitivity analysis

The assessment of publication bias and sensitivity regarding the association between night shift work and T2DM is detailed in Supplementary Figs. 1 and 2. The Begg's test indicated no significant publication bias ($P=0.371$). Sensitivity analysis, conducted using the leave-one-out method, confirmed the stability of the statistical results.

Discussion

This meta-analysis sought to investigate the relationship between night shift work and T2DM. The study synthesized data from 9 articles encompassing 10 cohort studies with over 235,800 participants, revealing a significant positive association between night shift work and the risk of developing T2DM. Specifically, the results of this

Table 2 Subgroup analyses assessing the association between night shift work and the risk of T2DM

Subgroup	No. of researches	No. of non-night shift work	No. of night shift work	HR	95%CI	*p*	I^2 (%)
Gender							
Female	5	89,748	104,578	1.28	(1.16,1.41)	< 0.001	57.8
Male	4	4340	6806	1.53	(0.89,2.63)	0.128	45.8
BMI							
≤ 30 kg/m2	2	22,549	6455	1.34	(0.81, 2.22)	0.255	87.4
> 30 kg/m2	2	7396	4018	1.14	(1.04, 1.25)	0.007	0
Profession							
Medical workers	3	70,597	93,617	1.33	(1.22, 1.46)	< 0.001	33.3
Non-medical workers	6	47,524	18,147	1.27	(1.07, 1.52)	0.007	55.2
Night shift duration							
≤ 5 years	2	70,425	73,519	1.05	(1.01, 1.10)	0.024	0
> 5 years	3	77,454	28,322	1.13	(1.09, 1.18)	< 0.001	0
≤ 10 years	3	89,399	77,454	1.06	(1.03, 1.10)	< 0.001	0
> 10 years	3	13,264	77,454	1.17	(1.10, 1.24)	< 0.001	0
Follow-up time							
≤ 10 years	5	30,847	15,822	1.43	(1.09, 1.86)	0.009	64.0
> 10 years	4	87,274	95,942	1.30	(1.18, 1.43)	< 0.001	48.2
Age							
≤ 60 years old	3	56,798	92,559	1.35	(1.20, 1.52)	< 0.001	44.6

NO: number; HR: hazard ratio; 95%CI: 95% confidence intervals; BMI: body mass index; T2DM: type 2 diabetes mellitus

meta-analysis show that night shift work exposed individuals have a 30% increased risk of T2DM compared to non-night shift exposed individuals. This association persisted across subgroup analyses by occupation (including medical and non-medical workers), duration of night shifts, and follow-up duration. Sensitivity analyses confirmed the stability of these results.

The increased risk among night shift workers may stem from disruptions in circadian rhythms. Normally, during the sleep phase under typical circadian conditions, vasopressin neurons in the suprachiasmatic nucleus (SCN) release vasopressin, which promotes the expression of glucose transporter 1 (GLUT1) in the arcuate nucleus (ARC). Night shift work disrupts this mechanism by directly affecting the SCN via the retinohypothalamic tract, leading to subsequent reduction in the activity of vasopressin neurons. This reduction in activity decreases GLUT1 expression in the ARC, thereby impairing glucose uptake, elevating circulating glucose levels, and promoting hyperglycemia [21–26].

Another critical pathway involves the hypothalamic suprachiasmatic nucleus, which releases various hormones that act on the paraventricular nucleus (PVN). The PVN influences the pineal gland to secrete melatonin via the sympathetic nervous system. Melatonin activates M1 and M2 receptors on the α and β cells of pancreatic islets, enhancing insulin secretion, promoting glycogen synthesis and glycolysis, inhibiting liver gluconeogenesis, and stimulating adipogenesis. Night shift work disrupts this pathway by suppressing PVN activation through light stimuli, resulting in reduced melatonin secretion from the pineal gland [27, 28]. This decrease in melatonin leads to lower insulin synthesis, reduced glucose utilization, and elevated circulating glucose levels [29]. Animal studies have demonstrated that melatonin supplementation can improve glucose metabolism in insulin-resistant mice fed high-fat diets [30].

Moreover, meta-analytical evidence from Delpino FM et al. suggests that melatonin may have an inhibitory effect on obesity. Experiments by Aubrecht et al. have shown that male mice exposed to dim light at night (dLAN) in conjunction with a high-fat diet (HFD) experience significant weight gain and impaired glucose tolerance, as well as diminished insulin secretion, indicating a synergistic effect between dLAN and HFD, where dLAN exacerbates the weight gain associated with HFD-induced obesity [31]. In the context of night shift work, many workers tend to consume late-night snacks, often high in fats. Our findings indicate that among those exposed to night shifts, individuals with obesity are at a heightened risk of developing T2DM, likely due to the described mechanisms. Conversely, non-obese individuals do not show an increased risk, possibly owing to their higher insulin sensitivity and more stable glucose levels.

Obese individuals exposed to night shifts experience exacerbated insulin resistance due to the dual impact of obesity and disrupted circadian rhythms. Clinical studies by Al-Sulaiti H et al. have shown that elevated levels of phospholipid metabolites such as choline, glycerophosphoethanolamine, and glycerophosphocholine are positively associated with insulin resistance in obese populations [32]. Obesity, often characterized by an increase in visceral fat, enhances lipid breakdown [33]. Adipose tissue, functioning as an endocrine organ,

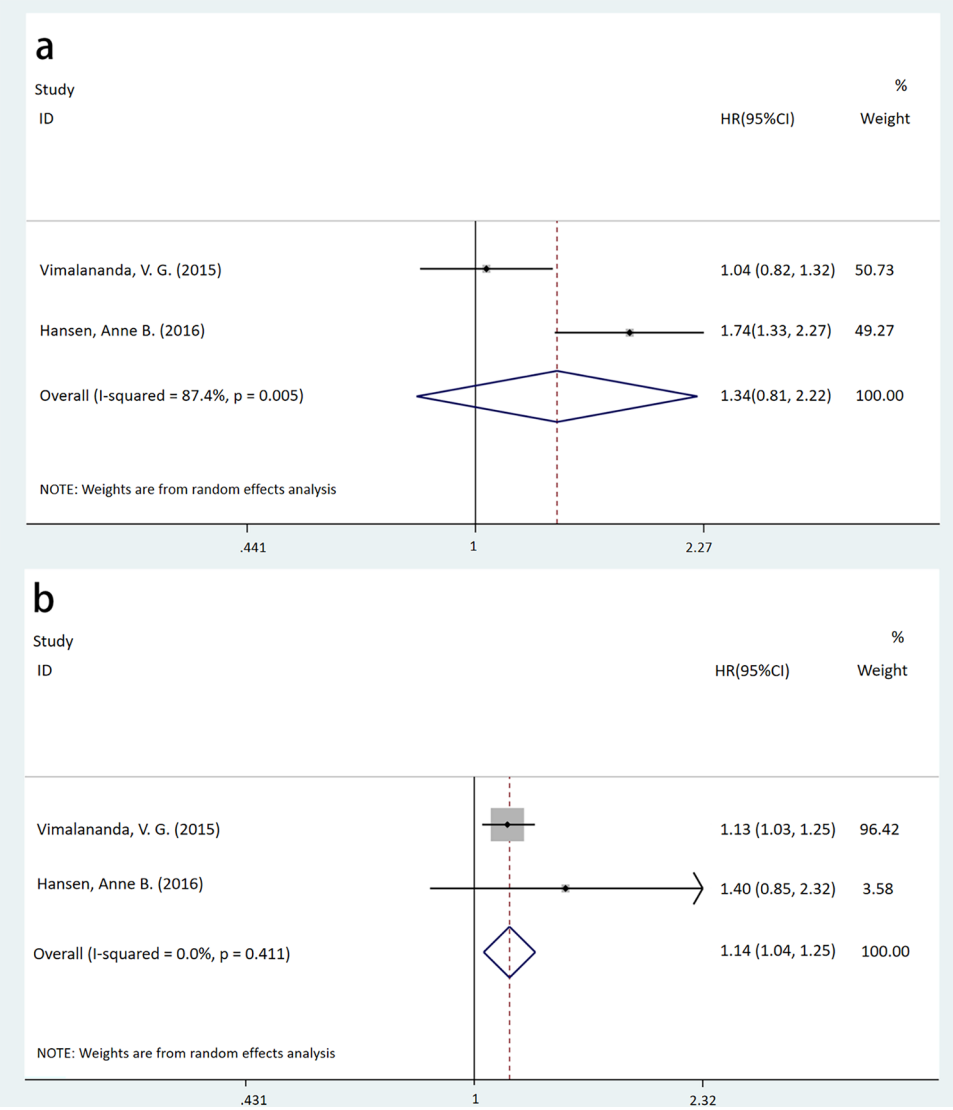

Fig. 4 Forest plots of a meta-analysis assessing the association between night shift work and the risk of T2DM across BMI subgroups (a: BMI ≤ 30 kg/m^2, $p = 0.255$; b: BMI > 30 kg/m^2, $p = 0.007$)

secretes various adipocyte-derived factors including free fatty acids (FFA), TNF-α, IL-6, leptin, adiponectin, visfatin, and other peptides [34]. FFAs, utilized for energy, reduce glucose uptake, thereby contributing significantly to insulin resistance. Pro-inflammatory cytokines such as TNF-α and IL-6, along with leptin, also promote insulin resistance, with TNF-α specifically inhibiting insulin receptor tyrosine kinase phosphorylation.

Additionally, there is significant evidence of gender disparities in the prevalence of T2DM, with females more frequently affected than males [35]. Our analysis indicates a positive association between night shift work and T2DM prevalence in the female subgroup, while no significant association was found in males. The association between higher BMI and increased T2DM risk is well-established. Systematic reviews have also shown that females are more likely to exhibit higher rates of obesity than males [36], and they have a greater rate of subcutaneous adipose tissue (SAT) formation and a more pronounced increase in waist circumference (WC) [37]. Furthermore, an increased WC is associated with a heightened risk of developing T2DM [38].

Meta-analytical evidence from previous research suggests significant gender association in hormonal profiles related to T2DM. Females generally exhibit higher levels of leptin and adiponectin compared to males of the same age and BMI. Notably, plasma adiponectin levels are inversely correlated with insulin sensitivity, a relationship that is more pronounced in females. Conversely, male testosterone levels, which suppress adiponectin secretion, appear to confer a protective effect against T2DM. Another previous meta-analysis further supports this

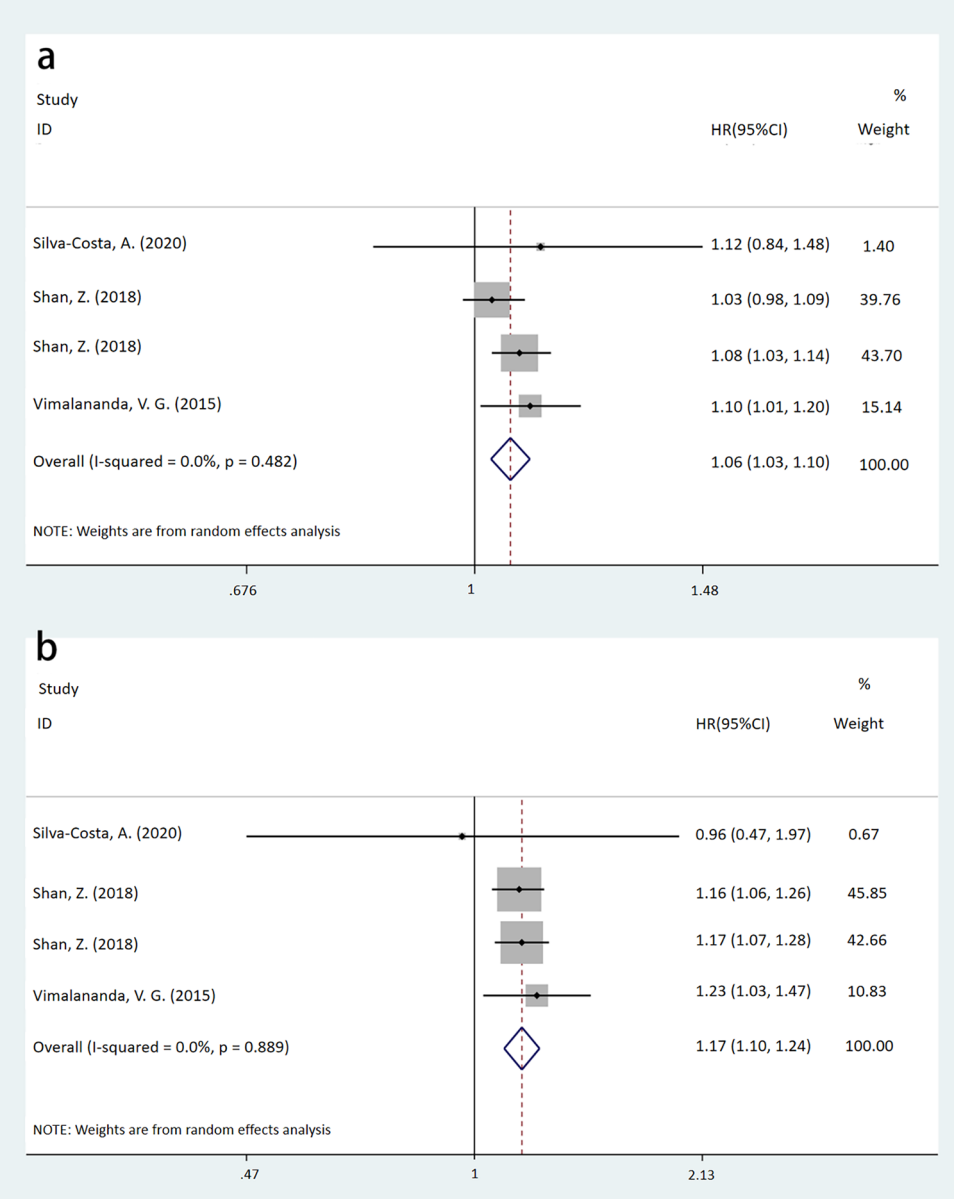

Fig. 5 Forest plots of a meta-analysis assessing the association between night shift work and the risk of T2DM across night shift duration subgroups (a: ≤10 years, $p < 0.001$; b: >10 years, $p < 0.001$)

by showing that men with T2DM have testosterone levels lower by 2.66 nmol/L than those without the disease [39, 40]. In this meta-analysis, it should be emphasized that since most of the cohort studies are nurse cohorts, the proportion of men is small. There are only more than 10,000 men, while there were nearly 200,000 women. The test power of the male subgroup is relatively low, so it is not easy to obtain positive results.

Additionally, women are more vulnerable to the adverse effects of social and occupational stressors, as well as sleep disorders [41]. Research indicates that night shift work exacerbates psychological stress and depression, particularly among women [42]. This stress activates the sympathetic nervous system, which in turn stimulates the hypothalamus to release corticotropin-releasing hormone (CRH), leading to adrenal cortex hormone release. Activating the hypothalamic-pituitary-adrenal axis, this process elevates cortisol levels, which promotes energy storage and mobilizes glucose and lipids into the bloodstream. Such hormonal fluctuations not only increase circulating glucose levels but also diminish insulin sensitivity, ultimately contributing to insulin resistance. Experimental findings by Fransson, L. et al. have shown that removal of the adrenal glands in mice leads to enhanced insulin sensitivity, underscoring the impact of adrenal hormones on glucose metabolism [43].

This study has demonstrated that prolonged exposure to night shifts is associated with an increased risk of developing T2DM, underscoring the detrimental effects linked to extended durations of such work schedules. In addition, the impact of night-shift exposure on the risk of T2DM may also be affected by various factors such as economic status, ethnicity, dietary conditions, and activity intensity. A cohort study has shown that the lower the household income, the higher the risk of diabetes in children or adolescents [44]. This may be related to the consumption of inexpensive and unhealthy food, poor lifestyle habits (smoking, excessive alcohol consumption) and socioeconomic stress among people with lower income. In another study, it has been indicated that a healthy diet and physical activity can reduce the incidence of T2DM [45]. Studies have also demonstrated that individuals of South Asian and African descent seem to be more susceptible to T2DM [46, 47]. This may be associated with genetic factors related to insulin resistance.

Our meta-analysis focused only on cohort studies with high-strength evidence and excluded pre-diabetic individuals. We used HR as the outcome measure for evaluating the risk of T2DM. Therefore, compared with the two previously published meta-analyses [9, 10], we only included 9 cohort studies. For example, the studies by Eriksson, A. K. et al. [48] and Ika, K. et al. [49] used odds ratio (OR) as the evaluation index; the study by Kita, T. et al. [50] was about the association between sleep duration/quality and diabetes risk, and the study by Oberlinner, C. et al. [51] focused on the impact of health examinations on the mortality rate of chronic diseases. None of these studies contained the HR index data of night shift work on the risk of T2DM.

Nevertheless, our study is not without limitations. Since in the included original studies the number of the female population was larger than that of the male, the lack of observed significant impact of night shift work on the prevalence of T2DM in the male subgroup might be related to the small sample size. For the subgroup analysis related to BMI, the ideal approach would be to use a dose-effect model and conduct linear regression analysis to explore the relationship between BMI and night shift work on the incidence of T2DM. Due to a lack of data, we can only perform subgroup analyses for BMI > 30 kg/m^2 and BMI ≤ 30 kg/m^2. Since there are differences in the adjustment factors of each original study and not all factors can be controlled, these can lead to biases in the results. The absence of detailed original data on variables such as age, intensity of night shift work, start times, and dietary habits restricted our ability to conduct more nuanced and diversified subgroup analyses. It is hoped that there will be more original research data in the future.

Conclusion

In summary, the present study establishes a correlation between night shift work and an elevated risk of T2DM, with the risk increasing as the duration of night shift exposure extends. Notably, this association exhibits gender-specific variations; the data reveal a discernible trend in women, whereas no significant trend is apparent in men. Regarding obesity status, a propensity for a stronger association with increased T2DM risk is observed among obese individuals, in contrast to their non-obese counterparts, where the association is less pronounced. These findings are consistent across various occupations, including medical and non-medical fields, diverse geographical regions, and multiple follow-up periods. While these results align with certain aspects of prior research, they underscore the need for further investigation and validation to elucidate the underlying mechanisms and potential occupational health interventions.

Abbreviations

95%CI	95% Confidence Interval
ARC	Arcuate Nucleus
BMI	Body Mass Index
CRH	Corticotropin-Releasing Hormone
dLAN	Dim Light at Night
FFA	Free Fatty Acids
FPG	fasting plasma glucose levels
GLUT1	Glucose Transporter 1
HR	Hazard Ratio
HFD	High-Fat Diet
NOS	Newcastle-Ottawa Scale
Odds ratio	OR
PVN	Paraventricular Nucleus
SAT	Subcutaneous Adipose Tissue
SCN	Suprachiasmatic Nucleus
SNS	Sympathetic Nervous System
T2DM	Type 2 Diabetes Mellitus
WC	Waist Circumference

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12902-024-01808-w.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

Supplementary Material 5

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None.

Author contributions

FX designed the research process. FX and KSH searched the database for corresponding articles. KSH and RRF extracted useful information from the articles above. YMZ used statistical software for analysis. FX, KSH and KQX drafted the meta-analysis. KSH and JNT polished this article. All authors had read and approved the manuscript and ensured that this was the case.

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Data availability
The datasets supporting the conclusions of this article are included within the article. For further details, please contact the corresponding author.

Declaration

Ethics approval and consent to participate
Not applicable, as this paper is based on research from global databases.

Clinical trial number
not applicable.

Consent to Publication
Not applicable.

Competing interests
The authors declare no competing interests.

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