

*Evidence-based Case Report*

**Examining The Relationship between Shift Work and Diabetes Mellitus among Nurses: An Evidence-based Case Report**

Angga Arifianto<sup>1\*</sup>, Indah Suci Widyahening<sup>2</sup>, Levina Chandra Khoe<sup>2</sup>, M. Ikhsan Mokoagow<sup>3</sup>

<sup>1</sup> Occupational Medicine Specialist Study Program, Faculty of Medicine, Universitas Indonesia, Jakarta

<sup>2</sup> Department of Community Medicine, Faculty of Medicine, Universitas Indonesia, Jakarta

<sup>3</sup> Department of Internal Medicine, Fatmawati Hospital, Jakarta

\*Email: [ankdutgha@gmail.com](mailto:ankdutgha@gmail.com)

ARTICLE INFO

ABSTRACT

**Article history**

Received: 15 April 2024

Revised: 2 June 2024

Accepted: 9 June 2024

**Keywords**

Shiftwork, Diabetes Mellitus, Nurses

**Background** Work shifts could cause numerous health problems, such as sleep disorders, weight gain disorders, and unhealthy food intake consumption, leading to obesity and changes in blood glucose levels, that eventually lead to diabetes mellitus. This evidence-based case report aims to provide evidence of the association between shift work and the risk of diabetes mellitus among nurses.

**Methods** We performed a literature search from Pubmed, Embase, Cochrane, Scopus, and Google Scholar in September 2023 using the keywords 'shift work' AND 'diabetes' AND 'nurse'. We included studies that assessed the association between shift work and diabetes among nurses using observational studies, meta-analysis, and systemic review as their study design. The outcome variable was the odd ratio or the relative risk of developing diabetes. We excluded cross-over studies, clinical trials, and cross-sectional studies. In addition, quality assessment was conducted according to The Oxford Center for Evidence-Based Medicine (OCEBM).

**Results** After title and abstract screening, we found seven out of twenty articles with a total of 689,273 participants. Among these articles, three cohort studies found an increased relative risk (1.08 to 2.60) of diabetes among nurses who worked night and rotating shifts compared to those who did not. Other evidence from two cohort studies and one meta-analysis identified that nurses who worked in full shifts had an increased risk of diabetes (1.05 to 3.60) than those who worked non-shifts. Factors affecting the risk of diabetes were gender, unhealthy lifestyle, sleep disorders, and shift work duration ( $\geq 10$  years).

**Conclusion** Shift work in nurses has a significant association with the risk of diabetes mellitus. Nurses who had been working shift work for more than 10 years, particularly on the night shift, had a higher risk compared to those who had been working for less than 10 years without a night shift. Additional factors such as obesity, smoking, lack of physical activity, unhealthy diet, and sleep disorders would increase the risk of diabetes mellitus.

## INTRODUCTION

In the modern world, 24-hour services contribute to the growing number of companies that require their employees to comply with rotating work schedules. The types of rotating work include full rotating shifts, evening work, and night work. Currently, around 23% of the working population in Europe work shifts or only work at night.<sup>1</sup> Shift work is a negative risk factor for workers' health, as the human body's natural defenses decrease at night.<sup>2</sup> It is worth considering that reduced levels of attention and alertness at night, combined with sleep deprivation and fatigue, can reduce work efficiency as well as increase the likelihood of work errors and injuries.<sup>2</sup>

The nursing profession is one of the most studied populations in terms of shift work. Most nurses work irregular working hours or have shift work with long working hours.<sup>3</sup> Shift work in nurses can cause psychological and physiological problems, increased risk of work errors, and decreased work quality.<sup>3</sup> Hansen and Stevens found that the longer the duration of shift work, especially at night, the greater the risk of developing type 2 diabetes; nurses with at least 20 years of night work experienced 24% increased risk.<sup>4</sup>

In Indonesia, the relationship between shift work and diabetes among nurses has not been studied yet. Based on Basic Health Research (Riskesmas), diabetes in Indonesia increased from 6.9 % in 2013 to 8.5 % in 2018; and the prevalence of diabetes among workers aged 18–54 years was 48%. In addition to having positive impacts on workers, such as the easiness of accessing daytime facilities during off time, better pay, and fewer work days per week, working shifts also cause unavoidable negative impacts.<sup>5</sup> We need to intervene at multiple levels, involving both organizations and individuals, to minimize the negative effects. As the aim of this evidence-based case report was to examine the relationship between work shifts and diabetes, it is necessary to conduct a systematic search for evidence on the relationship between diabetes mellitus and shift work among nurses.

## CASE DESCRIPTION

A 48-year-old male nurse who worked in the hospital surgery room came for a periodic health check. At the time of anamnesis, he complained of a tingling sensation in his palms that came and went away at an uncertain time. He often felt it at night, from before going to bed and in the morning when waking up. The sensation improved when he used his hand more and only started again at night. He felt the sensation from the tips of his fingers creeping to his palms in both hands since 2 years ago. It did not interfere with his daily activities as he still could do his activities well, including his work as a surgical nurse. After this complaint, the patient visited a Neurologist and was diagnosed with DM Neuropathy. He was given anti-pain medication, if needed, and neuroprotector vitamins as well as was recommended to control his blood sugar levels. He also suffered from DM and hypertension for more than 5 years and regularly visited an Internist. The Internist prescribed him two types of oral anti-diabetic drugs, i.e. metformin (2 times a day), glimepiride (1 mg once a day), and amlodipine (5 mg once a day). The patient had been working for more than 20 years as a nurse in the surgery room and in rotating shift work since the beginning.

Based on his physical examination, his blood pressure was 145/90 mmHg, body mass index 33.2, waist circumference 112 cm, and pelvic circumference 110 cm. In addition, the results of his bilateral upper extremity neurological examination were: physiological tendon reflexes (+), pathological reflexes (-), normal muscle tone, normal sensory examination (+), Neuropathy Symptom Score was 4 (mild), Tinnel test (-), and Phalen test (-). On the other hand, the results of his laboratory tests were: hemoglobin 16,7 g/dl, leucocyte 8.000/mm<sup>3</sup>, thrombocyte 209.000/mm<sup>3</sup>, fasting serum glucose/2h postprandial glucose 300/307 mg/dl, and lipid profile consists of triglyceride/ total cholesterol/ HDL/ LDL were 285/236/38/141 mg/dl.

## PROBLEM FORMULATION

Is there any relationship between working shifts and the occurrence of diabetes mellitus in nurses?

## EVIDENCE SEARCH STRATEGY

To address the problem formulation, the articles were searched in five electronic databases, i.e. PubMed, EMBASE, Cochrane, Scopus, and Google Scholar. The keywords were "shift work", "night shift work", "rotating shift work", "shift work schedule", "nurses", "diabetes", "diabetes mellitus", "diabetes mellitus type 2", and "diabetes complications" or their synonyms as determined by the authors. The search utilized MeSH terms and title/abstract fields, combined with Boolean operators "OR" and "AND". The preferred study designs were Systematic Review/Meta-Analysis of cohorts,

cohort studies, and case controls. The inclusion criteria were nurses, shift work, and diabetes mellitus whose research area was therapy with study design of systematic reviews/meta-analysis of cohorts, cohort study, retrospective study, and English full-text articles. Meanwhile, the exclusion criteria were crossover study, cross-sectional study, RCT, irrelevant, wrong outcomes, and articles with incomplete data or inaccessible full text. The literature search was completed on 12<sup>th</sup> September 2023. The obtained literature was critically appraised using the validity-importance-applicability (VIA) framework using the etiology worksheet from the Oxford Centre for Evidence-Based Medicine. The level of evidence was determined following the Oxford Centre for Evidence-Based Medicine 2011 guidelines.<sup>6</sup>

## RESULT

The literature search was finished on 12<sup>th</sup> September 2023 using the following electronic databases: (See Table 1)

**Table 1. Articles searching strategy 1**

<i>Database</i>	<i>Search strategy</i>	<i>Hit</i>	<i>Selection</i>
PubMed	(((((shift work[Title/Abstract]) OR (Rotating Shift Work[Title/Abstract])) OR (Night Shift Work[Title/Abstract])) OR (Shift Work Schedule[Title/Abstract])) OR (rotating night shift work[Title/Abstract])) AND (((Diabetes Mellitus[Title/Abstract]) OR (diabetes)) OR (diabetes mellitus type 2[Title/Abstract])) OR (Diabetes Complications[Title/Abstract])) AND (Nurse[Title/Abstract])	9	3
Cochrane	("shift-work"):ti,ab,kw AND ("diabetes mellitus"):ti,ab,kw AND (nurse):ti,ab,kw"	3	1
Embase	('shift work':ab,ti OR 'shift schedule':ti,ab,kw OR 'night shift':ab,ti OR 'rotating shift':ab,ti) AND 'diabetes mellitus':ab,ti OR 'non-insulin-dependent diabetes mellitus':ab,ti OR 'diabetic complication':ab,ti) AND nurse:ti,ab,kw	26	0
Scopus	shift AND work OR night AND shift OR rotating AND shift OR shift AND work AND schedule AND diabetes AND mellitus OR diabetes AND mellitus AND type 2 OR diabetes AND mellitus AND complications AND nurse	139	2
Google Scholar	allintitle: shift work and diabetes and nurses	4	2

During the selection process, titles/abstracts from the five electronic databases were screened; and after checking for duplicates, a total of 181 articles were identified. Subsequently, the screening was carried out by reading the articles' titles and abstracts, resulting in 8 articles that were then filtered further based on eligibility criteria.

A total of seven articles were identified for critical appraisal to address the clinical question. See **Figure 1** for the search strategy scheme.

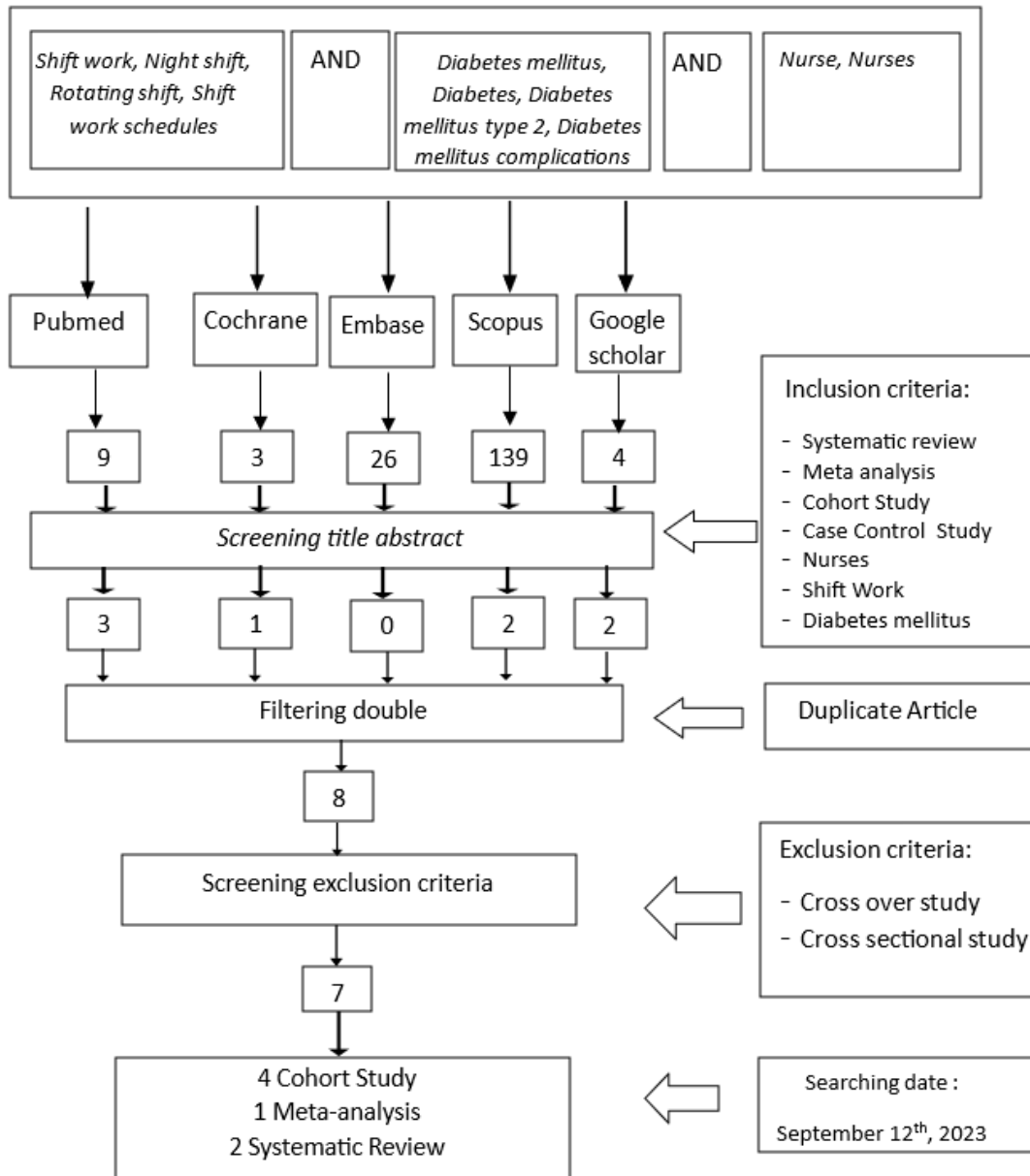


Figure 1. Article searching flow chart 1

The seven selected articles were studies by Hansen *et al.*, Zoto *et al.*, Shan *et al.*, Viklund *et al.*, Rosa *et al.*, Rivera *et al.*, and Gan *et al.*, which were then reviewed further using the etiology worksheet from the Oxford Center for Evidence-Based Medicine.<sup>6</sup> See **Table 2** for details on selected articles' characteristics.

Table 2. Characteristics of included studies

Researcher & year of study	Country	Study design	Populations	Number of subjects or studies	Risk factor	Outcome
Hansen <i>et al.</i> (2016) <sup>1</sup>	Denmark	Cohort	Danish nurses member of Danish Nursing Organization, Denmark	19.873	Evening shift, Night shift, Rotating shift	There was an increased risk in the night work-only group (HR 1.73; CI 95% 1.37-2.19), evening shift work group (HR 1.29; CI 95% 1.04-1.59), and full shift group (HR 1.08; CI 95% 0.91-1.28). Adjustment to BMI of the night shift only group (HR 1.58; CI 95% 1.25-1.99). (Level of Evidence IIB)
Zoto <i>et al.</i> (2019) <sup>7</sup>	Albania	Cohort	The Universital hospital "Shefqet Ndroqi" in Tirana and Regional Hospital of Durres (Spitali Rajonal Durrës), Albania	186	Night shift	The risk in the night work-only group (HR 2.602; 95% CI 1.011-5.021) (Level of Evidence IIB)
Shan <i>et al.</i> (2018) <sup>8</sup>	US	Cohort	The Nurses' Health Study (NHS) and NHS II.	143.41	Rotating shift	There was an increased risk of diabetes in the 1-5 years shift work (HR 1.09; CI 95% 0.99-1.21), 5-9 years shift work (HR 1.28; CI 95% 1.09-1.51), and ≥10 years shift work (HR 1.47; CI 95% 1.32-1.65). Multivariate analysis of BMI adjustment (HR 1.16; CI 95% 1.09-1.24). Multivariate analysis of lifestyle adjustment for shift workers ≥ 10 years (HR 1.46; CI 95% 1.33-1.62) (Level of Evidence IIB)
Viklund <i>et al.</i> (2023) <sup>9</sup>	Sweden	Cohort	Nurses and nursing assistants including caregivers, personal assistants, and accommodation assistants	28.841	Day and afternoon shift, day and/or afternoon shift with night shift, night shift only	The risk in the night work only (HR 1.59; 95% CI 1.02-2.43) and the night shift work >120 times per year group (HR 1.34; 95% CI 1.11-2.48) (Level of Evidence IIB)
Rosa <i>et al.</i> (2019) <sup>2</sup>	Italy	Systematic Review	Nurses	24	Shift work, night work, work schedule tolerance	Diabetes risk with an HR of 4.17 (95% CI, 2.93-5.91, p = 0.0001). (Level of Evidence IIA)
Rivera <i>et al.</i> (2020) <sup>10</sup>	US	Systematic Review with Meta-Analyses	Factory worker, Nurses	48	Shift work, long work hours	Diabetes risk with a RR 1.4 (95% CI 1.18-1.66) with I <sup>2</sup> = 95% (Level of Evidence IIA)
Gan <i>et al.</i> (2014) <sup>11</sup>	China	Meta-Analyses	Manufacture Workers, pulp and paper workers, Nurses	28	Shift work	Diabetes risk with an OR 1.4 (95% CI 1.18-1.66) with I <sup>2</sup> = 40.9% (Level of Evidence IIA)

**Data Collection**

Critical appraisal was conducted in terms of the validity, importance, and applicability of each previously identified study. See **Table 3–4** for the results of the critical appraisal of the literature used to address the clinical question. For a more detailed description of the journal appraisal, see **Appendix 1**.

**Table 3. The summary of critical appraisal on the importance, applicability, and level of evidence of the observational studies**

	Parameter	Study			
		Hansen, <i>et al.</i> <sup>1</sup>	Zoto, <i>et al.</i> <sup>7</sup>	Shan, <i>et al.</i> <sup>8</sup>	Viklund, <i>et al.</i> <sup>9</sup>
<b>Validity</b>	Similarity between groups?	Yes	Yes	Yes	Yes
	Exposure measured in the same ways?	Yes	Yes	Yes	Yes
	Follow up long and complete?	Yes	Yes	Yes	Yes
	Did exposure precede the outcome?	Yes	Yes	Yes	Yes
	Is there a dose-response gradient?	No	No	Yes	No
	Is there a “dechallenge-rechallenge” study?	No	No	No	No
	Consistent from study to study?	Yes	No	Yes	Yes
	Does association make biological sense?	Yes	Yes	Yes	Yes
<b>Importance</b>	What is the magnitude of the association between the exposure and outcome?	Yes, there was an increased diabetes risk in the night work only (HR 1.73; CI 95% 1.37-2.19), afternoon shift work (HR 1.29; CI 95% 1.04-1.59), and full shift (HR 1.08; CI 95% 0.91-1.28).	Yes, there was an increased risk in the night work only (OR 2.602; CI 95% 1.011-5.021).	Yes, there was an increased risk of diabetes in the 1-5 years shift work group (HR 1.09; CI 95% 0.99-1.21), 5-9 years shift work group (HR 1.28; CI 95% 1.09-1.51), and ≥10 years shift group (HR 1.47; CI 95% 1.32-1.65).	Yes, there was an increased risk in the night work only (HR 1.59; 95% CI 1.02-2.43), full shift work (HR 1.13; 95% CI 0.73-1.73), morning and evening shift (HR 1.34; 95% CI 0.97-1.88), and night shift work >120 times per year (HR 1.34; 95% CI 1.11-2.48).
	The precision of the estimate of the association?	Yes	Yes	Yes	Yes
<b>Applicability</b>	Can be extrapolated to the patient?	Yes	Yes	Yes	Yes
	<b>Level of evidence</b>	2B	2B	2B	2B

**Table 4. The summary of critical appraisal on the importance, applicability, and level of evidence of the systematic review and meta-analysis studies**

Parameter	Study			
	Rosa, <i>et al.</i> <sup>2</sup>	Rivera, <i>et al.</i> <sup>10</sup>	Gan, <i>et al.</i> <sup>11</sup>	
<b>Validity</b>	What question (PICO) did the systematic review address?	Yes	Yes	Yes
	Is it unlikely that important, relevant studies were missed?	Yes	Yes	Yes
	Were the criteria used to select articles for inclusion appropriate?	Yes	Yes	Yes
	Were the included studies sufficiently valid for the type of question asked?	Yes	Yes	Yes
<b>Results</b>	Were the results do statistical analyses?	No	Yes the results RR value 1.4 (95% CI; 1.18 - 1.66; p<0.001), there was an association between diabetes risk and shift work.	Yes the results of a pooled adjusted OR for the association between every exposure to shift work and DM risk was 1.09 (95% CI 1.05 to 1.12; p=0.014)
	Were the results exploring heterogeneity?	No	Yes	Yes
<b>Level of evidence</b>		2A	2A	2A

## DISCUSSION

Based on the articles found in the literature search, there was an association between shift work and diabetes risk. The risk increased in both nurses working full shifts of more than 10 years (HR 1.47; 95% CI 1.32–1.65) and those working night shifts only (HR 1.59; 95% CI 1.02–2.43 to HR 1.73; 95% CI 1.37–2.19).

In addition, the patient described in the case description had been working shifts for about 20 years. The length of the shift work in nurses was known to be associated with the occurrence of diabetes, as per Shan *et al.*<sup>8</sup> who found that nurses working shifts for more than 10 years increased the risk of developing diabetes (HR 1.47; 95% CI 1.32–1.65), higher than those working shifts for 1–5 years and 5–9 years (HR 1.09; 95% CI 0.99–1.21 and HR 1.28; 95% CI 1.09–4.51, respectively).





The patient also had other risk factors, such as obesity (BMI 33.2), smoking 10–15 cigarettes per day, and barely working out. According to Shan *et al.*,<sup>8</sup> shift work combined with each unhealthy lifestyle factor (smoking, obesity, lack of physical activity, and unhealthy diet) increases diabetes risk to 2.30 (95% CI 1.88–2.83)  $p < 0.01$ . Meanwhile, the risk of shift work combined with three unhealthy lifestyle factors increases the risk to 2.83 (95% CI 2.15–3.73,  $p < 0.01$ ). The proportion of the risk distribution for such a combination was 17.1% (95% CI 14–20.8%) for shift work alone, 71.2% (95% CI 66.9–75.8%) for unhealthy lifestyle alone, and 11.3% (95% CI 7.3–17.3%) for the combination of shift work and unhealthy lifestyle. This suggested that an unhealthy lifestyle is a major risk factor for diabetes, and the combined interaction has an effect of 11.3%. This was also similar to a study by Hansen *et al.*<sup>1</sup> who suggested that shift work combined with BMI adjustment increased diabetes risk to 1.29 (95% CI 1.04–1.59).

Another contributing factor in the case was gender. According to Gan *et al.*<sup>11</sup>, the risk for males was 1.37 (95% CI 1.20–1.56), higher than females 1.09 (95% CI 1.04–1.14). In addition, the other factor was lack of sleep which decreased the patient's sleep quality

when working shifts. According to Zoto *et al.*<sup>7</sup>, shift workers, especially those who work night shifts, have poor sleep quality has an insignificant connection with the risk of diabetes (HR 1.29, 95% CI 0.542–3.112;  $p = 0.557$ ). In striking contrast, Rosa *et al.*<sup>2</sup> stated that sleep disorders, such as snoring during sleep, lack of sleep (less than 6 hours), or apnea during sleep, were found significantly associated with type-2 diabetes mellitus where sleep disorders increased the risk of diabetes among nurses to 4.17 (95% CI 2.93–5.91,  $p = 0.0001$ ).

The increased risk of type-2 diabetes and rotating night shift work were found associated with several potential mechanisms. First, rotating night shift work was generally associated with chronic misalignment between the endogenous circadian timing system and the behavior cycles. This circadian misalignment has long been found to have adverse metabolic and cardiovascular consequences, including decreased leptin, increased glucose and insulin, increased average arterial blood pressure, and reduced sleep efficiency. Second, changes in the health-related behaviors (such as smoking and irregular meals) of workers with rotating night shifts might explain these observed associations.<sup>12</sup>

The strengths of this evidence-based case report were the literature studied large populations of nurses and found that there was a relation between nurses working full shifts and the risk of diabetes; similar to the conditions of the patient described in this case report. In addition, other risk factors were also found, such as the length of working full shifts, unhealthy lifestyles, sleep disorders, and gender where males had a higher risk of diabetes for nurses working full shifts.

On the other hand, this report did face several limitations, such as unclear definitions of work shift patterns across the literature which can be different from each country. In addition, the populations studied in the meta-analysis by Gan *et al.*<sup>11</sup> and in the systematic review by Rivera *et al.*<sup>10</sup> were not only nurses but rather from other types of occupations as well.

## CONCLUSION

Based on the literature search, several scientific evidence proving the association between shift work and the risk of diabetes mellitus answered the clinical question in this case report. The scientific evidence from three cohort studies suggested that only night shift work can already increase the risk of diabetes from 1.59 to 2.60. In addition, the scientific evidence from two cohort studies and one meta-analysis suggested that rotating shift work can increase the risk of diabetes from 1.05 to 1.47 times higher than nurses working non-shifts. The risk increases 1.31 times for every 5 years of rotating shift work. The risk of diabetes also increases from 2.60 to 4.17 times higher when shift work is combined with sleep disorders, such as snoring, sleeping less than 6 hours, and sleep apnea. In addition, shift work combined with three unhealthy lifestyle factors (smoking, obesity, lack of physical activity, and unhealthy diet) increases diabetes risk by 2.83 times. Moreover, the male also has a higher risk of diabetes (1.37) than female (1.09).

It is recommended that employers provide health education about diabetes mellitus among nurses and the importance of maintaining health. They can provide them through nutrition and diet counseling, exercise facilities, and fitness programs such as group workout activity and weight loss programs for obese nurses, smoking cessation programs, as well as compulsory periodical medical checks. As for nurses, they should reduce their unhealthy lifestyle risk factors for diabetes, such as smoking habits, obesity, unhealthy food, and poor sleep quality.

## DECLARATION

**Acknowledgments:** -

**Financial Disclosure:** No competing financial interest exists

**Conflict of Interests:** The authors have no conflict of interest to disclose.

## REFERENCE

1. Hansen, A. B., Stayner, L., Hansen, J. & Andersen, Z. J. Night shift work and incidence of diabetes in the Danish Nurse Cohort. *Occup Environ Med* 73, 262–268 (2016). <https://doi.org/10.1136/oemed-2015-103342>
2. Rosa, D., Terzoni, S., Dellafiore, F. & Destrebecq, A. Systematic review of shift work and nurses' health. *Occup Med (Chic Ill)* 69, 237–243 (2019). <https://doi.org/10.1093/occmed/kqz063>
3. Romano, M., Festini, F. & Bronner, L. [Cross-sectional study on the determinants of work stress for nurses and intention of leaving the profession]. *Prof Inferm* 68, 203–10 (2015).
4. Hansen, J. & Stevens, R. G. Case-control study of shift-work and breast cancer risk in Danish nurses: Impact of shift systems. *Eur J Cancer* 48, 1722–1729 (2012). <https://doi.org/10.1016/j.ejca.2011.07.005>
5. Ogeill, R. P., Savic, M., Ferguson, N. & Lubman, D. I. Shift-Work-Play: Understanding the positive and negative experiences of male and female shift workers to inform opportunities for intervention to improve health and wellbeing. *Australian Journal of Advanced Nursing* 38, (2021). <https://doi.org/10.37464/2020.382.181>
6. Howick, J., Chalmers, I., Glasziou, P. & OCEBM Levels of Evidence Working Group. *The Oxford 2011 Levels of Evidence*. <https://www.cebm.ox.ac.uk/resources/levels-of-evidence/ocebml-levels-of-evidence> (2024).
7. Zoto, E., Cenko, F., Doci, P. & Rizza, S. Effect of night shift work on risk of diabetes in healthy nurses in Albania. *Acta Diabetol* 56, 811–813 (2019). <https://doi.org/10.1007/s00592-019-01307-8>
8. Shan, Z. *et al.* Rotating night shift work and adherence to unhealthy lifestyle in predicting risk of type 2 diabetes: results from two large US cohorts of female nurses. *BMJ* k4641 (2018). <https://doi.org/10.1136/bmj.k4641>
9. Viklund, A. *et al.* Night and shift work patterns and incidence of type 2 diabetes and hypertension in a prospective cohort study of healthcare employees. *Scand J Work Environ Health* 49, 439–448 (2023). <https://doi.org/10.5271/sjweh.4104>
10. Rivera, A. S., Akanbi, M., O'Dwyer, L. C. & McHugh, M. Shift work and long work hours and their association with chronic health conditions: A systematic review of systematic reviews with meta-analyses. *PLoS One* 15, e0231037 (2020). <https://doi.org/10.1371/journal.pone.0231037>
11. Gan, Y. *et al.* Shift work and diabetes mellitus: a meta-analysis of observational studies. *Occup Environ Med* 72, 72–78 (2015). <https://doi.org/10.1136/oemed-2014-102150>
12. Pan, A., Schernhammer, E. S., Sun, Q. & Hu, F. B. Rotating Night Shift Work and Risk of Type 2 Diabetes: Two Prospective Cohort Studies in Women. *PLoS Med* 8, e1001141 (2011). <https://doi.org/10.1371/journal.pmed.1001141>



**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.