Metabolic Syndrome and Rotational Shift Work Among Female Nurses: Assessing Occupational Health Risks

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ABSTRACT

Background: Nurses involved in rotating shift duties are especially at risk of metabolic syndrome (MetS) due to circadian rhythm disturbances and work-related stress. This study aimed to determine the prevalence and determinants of MetS among female nurses working rotational shifts in a tertiary public hospital in Western India. **Methods:** This cross-sectional study included 71 randomly selected female nurses aged 21–59 years, each with atleast two years of shift-work experience. MetS was diagnosed using the modified National Cholesterol Education Program Adult Treatment Panel III criteria. Anthropometric, biochemical, and blood pressure measurements, along with perceived stress scores (Perceived Stress Scale) were collected. **Results:** The prevalence of MetS was 32.4%. Significant associations were found with age (p = 0.04), total work experience (p = 0.01), number of night shifts (p = 0.02), and duration of rotational shift work (p < 0.001). Low HDL (95.8%) and elevated random blood glucose (64.8%) were the most common components. Logistic regression revealed duration of rotational shift work as an independent predictor (OR = 1.32; 95% CI: 1.02–1.86; p = 0.047). **Conclusion:** The study highlights the need for preventive interventions, including optimized shift scheduling and periodic metabolic screening among shift-working nurses.

INTRODUCTION

Metabolic syndrome (MetS) was first described by the World Health Organization (WHO) in 1988 as a combination of insulin resistance, impaired glucose tolerance, or type 2 diabetes, with at least two additional factors such as elevated blood pressure, hypertriglyceridemia, low HDL-cholesterol, obesity, or microalbuminuria (1). Since then, MetS has gained global attention for its strong link to cardiovascular disease and diabetes. The National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) later standardized its diagnostic criteria based on abdominal obesity, triglycerides, HDL-cholesterol, blood pressure, and fasting glucose (2). In India, MetS affects nearly one-fourth of adults, with a higher prevalence among females (3–6). Employment type and gender significantly influence MetS risk (6). Among healthcare workers, prevalence is reported at 24.2% (7). Nurses, particularly, face multiple stressors such as staff shortages, high workload, and strained professional relations (8), predisposing them to MetS and other disorders like work-related musculoskeletal disorders (9). Stress-driven unhealthy behaviors exacerbate related risk factors (10). Shift work, especially night duty, disrupts circadian rhythm and heightens MetS risk (11–17). Limited Indian studies have addressed this issue among female nurses.

Objectives:

a) To determine the prevalence of metabolic syndrome among female nurses engaged in rotational shifts.

b) To identify occupational factors associated with MetS in this group.

MATERIAL & METHODS

Study Design and Setting: This cross-sectional study was performed at tertiary public hospitals in Patan district, Gujarat, India. This hospital is an apex hospital which serves patient from entire district as well as nearby districts and therefore experiences a substantial workload managed by a large number of female nurses. The study focussed on the prevalence of metabolic syndrome and its risk factors among female nurses engaged in shift duties at this hospital. The design followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting cross-sectional design.

Participants and Sampling: A random sampling technique was utilized to include 88 female nurses working in tertiary public hospital. The inclusion criteria required female nurses aged 21-59 years who had been engaged in shift duty for at least two years. Nurses with known history of diabetes, hypertension, or high lipid profiles before joining this occupation were excluded. Based on previous studies indicating 35% prevalence of metabolic syndrome in population in India, a sample size of 88 was calculated to estimate the expected proportion with 10% precision and 95% confidence.

Data Collection Tools: Data collection included measuring anthropometric parameters along with gathering demographic, nutritional, and perceived stress information. After obtaining written informed consent, participants' height, weight, waist circumference, and BMI were recorded. Height was measured using a stadiometer, with participants standing upright, barefoot, heels together, and head aligned in the Frankfort horizontal plane. Weight was taken using a calibrated digital scale, with participants wearing light clothing and no footwear. Waist circumference was assessed with a non-elastic measuring tape placed midway between the lower edge of the last palpable rib and the iliac crest. BMI was computed as weight (kg) divided by height (m²).

A structured questionnaire was administered to obtain information on participants' nutrition and demographic characteristics. Interviews were conducted privately to ensure confidentiality and comfort. The questionnaire covered dietary patterns—including meal frequency and consumption of tea or coffee—as well as demographic variables such as age, education, marital status, and menstrual history. A pilot test was carried out to assess the clarity and reliability of the tool before data collection. All interviews were conducted by trained field investigators who underwent standardized training on interview techniques and study procedures. Each interview typically lasted 20–30 minutes.

The Perceived Stress Scale (PSS) was used to assess stress levels. Participants rated a set of statements reflecting their thoughts and feelings over the past month on a 0–4 scale (from "never" to "very often"). The PSS is a widely used and validated tool for measuring perceived stress across different populations.

Blood samples were obtained using standard phlebotomy techniques to maintain accuracy and avoid contamination. Participants were advised to fast for at least 8 hours prior to sample collection. Venous blood was drawn from the antecubital vein using sterile equipment and transferred into appropriate tubes. Fasting levels of plasma glucose, LDL, HDL cholesterol, and triglyceride were analysed using standard enzymatic assays in an accredited laboratory.

Blood pressure was measured using a calibrated sphygmomanometer. Participants were seated in a relaxed position with their back supported, feet flat on the floor, and the arm positioned at heart level. After resting for at least 5 minutes, two measurements were taken, spaced 5 minutes apart, and their average was used. If the two readings differed by more than 10 mmHg, a third reading was taken, and the mean of all three values was recorded.

Metabolic syndrome was diagnosed based on the modified National Cholesterol Education Program (NCEP) Adult Treatment Panel III guidelines, requiring at least three of the following five criteria: blood pressure ≥130/85 mmHg or current antihypertensive treatment; fasting blood glucose ≥110 mg/dL or treatment for elevated glucose; triglyceride levels ≥150 mg/dL or medication for dyslipidemia; HDL cholesterol <50 mg/dL in females or lipid-lowering treatment; and waist circumference >35 inches in females. (2)

Data Analysis

Data were entered in MS Excel and analysed using SPSS version 26.0. Descriptive statistics were used to present the demographic and clinical profiles of the participants. The overall prevalence of metabolic syndrome was computed for the study sample. Logistic regression was applied to determine the independent factors linked to metabolic syndrome in the study population.

RESULTS

The study investigated the association between metabolic syndrome and several demographic, occupational, and lifestyle factors among 71 female nurses, of whom 23 (32.4%) were diagnosed with metabolic syndrome. Age showed a significant association with metabolic syndrome (p = 0.04), with the highest prevalence observed among nurses aged 31–40 years (56.5%) and the lowest among those aged 18–30 years (17.4%). Total work experience also showed a significant association (p = 0.01), as nurses with over 10 years of experience had a prevalence of 56.5%, compared to 34.8% in those with 6–10 years and just 8.7% in those with 1–5 years. The frequency of night shifts per month was significantly linked to metabolic syndrome (p = 0.02); nurses working more than six night shifts had a prevalence of 65.2%, compared to 34.8% in those with six or fewer. The duration of working in rotational shifts was highly significant (p < 0.001), with a prevalence of 47.8% in nurses with over 10 years of rotational shift experience, compared to 13.1% in those with 1–5 years. Furthermore, a lack of physical exercise was associated significantly with metabolic syndrome (p = 0.01).

Table 2 highlights the parameters of metabolic syndrome. Elevated waist circumference (>35 inches) was observed in 21.1% of the participants, elevated triglyceride levels (≥150 mg/dL) were present in 22.5% of the nurses, low HDL levels (<50 mg/dL) were notably prevalent in 95.8% of the participants, elevated systolic blood pressure (SBP ≥130 mmHg) and diastolic blood pressure (DBP ≥85 mmHg) were each recorded in 8.5% of nurses, and elevated random blood sugar (RBS ≥110 mg/dL) was observed in 64.8% of participants. Overall, 32.4% (n = 23) of the nurses met the criteria for metabolic syndrome. These findings indicate a high prevalence of key metabolic syndrome components, particularly low HDL levels and elevated RBS, among female nurses.

The Perceived Stress Scale (PSS) scores of female nurses with and without metabolic syndrome revealed no statistically significant differences across all parameters. Nurses with metabolic syndrome reported slightly higher mean scores for feeling nervous and stressed (0.69 ± 0.7 vs. 0.48 ± 0.7, p = 0.22) and not able to control major life matters (0.52 ± 0.7 vs. 0.27 ± 0.57, p = 0.12). The overall PSS scores were comparable between the two groups (16.3 ± 2.7 for metabolic syndrome vs. 15.9 ± 2.7 for no metabolic syndrome, p = 0.64), suggesting that perceived stress levels were not significantly differing between nurses with and without metabolic syndrome (Table 3).

Logistic regression analysis identified years of rotational shift duty as a significant predictor of metabolic syndrome among female nurses (OR = 1.32, 95% CI: 1.02–1.86, p = 0.047), suggesting that longer exposure to rotational shifts increases the risk. Age also showed a borderline association with the metabolic syndrome (OR = 1.36, 95% CI: 0.99–1.86, p = 0.055), indicating a potential age-related risk that did not reach statistical significance. Other factors, including total work experience (OR = 1.12, 95% CI: 0.86–3.62, p = 0.128), highly consumed meal during dinner (OR = 1.38, 95% CI: 0.96–5.12, p = 0.752), physical activity (OR = 0.43, 95% CI: 0.06–2.96, p = 0.391), and perceived stress score (OR = 0.97, 95% CI: 0.75–1.25, p = 0.799), were not significantly associated with metabolic syndrome (Table 4).

Table 1: Demographics and occupation of female nurses and its relationship with metabolic syndrome

Variables	Metabolic syndrome		Significance
	Yes (n = 23)	No (n = 48)	
Age (years), n (%)			
18 – 30	04 (17.4)	22 (45.8)	p = 0.04
31 – 40	13 (56.5)	21 (43.8)	
> 40	06 (26.1)	05 (10.4)	
Marital status, n (%)			
Married	20 (87.0)	34 (70.8)	p = 0.52
Unmarried	03 (13.0)	13 (27.1)	
Widow	0 (0)	01 (2.1)	
Family structure, n (%)			
Nuclear	11 (47.8)	24 (50.0)	p = 0.86
Joint	12 (52.2)	24 (50.0)	
Total work experience as nurse, n (%)			
1 – 5	02 (8.7)	20 (41.7)	p = 0.01
6 – 10	08 (34.8)	13 (27.1)	
> 10	13 (56.5)	15 (31.2)	
Frequency of night shifts (days per month), n (%)			

≤ 6	08 (34.8)	06 (12.5)	p = 0.02
> 6	15 (65.2)	42 (87.5)	
Working years in rotational shift, n (%)			
1 – 5	03 (13.1)	24 (50.0)	p = 0.000
6 – 10	09 (39.1)	15 (31.2)	
> 10	11 (47.8)	09 (18.8)	
Physical exercise, n (%)			
Yes	03 (35.7)	04 (6.2)	p = 0.01
No	20 (33.3)	44 (18.8)	

Table 2: Metabolic syndrome parameters in female nurses.

Variables	Frequency (%)
Circumference of waist	
>35 inch	15 (21.1%)
≤35 inch	56 (78.9%)
Triglyceride level	
≥150 mg/dL	16 (22.5%)
<150 mg/dL	55 (77.5%)
HDL level	
<50 mg/dL	68 (95.8%)
≥50 mg/dL	3 (4.2%)
SBP level	
≥130 mmHg	6 (8.5%)
<130 mmHg	65 (91.5%)
DBP level	
≥85 mmHg	6 (8.5%)
<85 mmHg	65 (91.5%)
RBS level	
≥110 mg/dL	46 (64.8%)
<110 mg/dL	25 (35.2%)
Metabolic syndrome	
Yes	23 (32.4%)
No	48 (67.6%)

Table 3: Association between perceived stress score and presence of metabolic syndrome in female nurses.

Variables	Metabolic syndrome		Significance
	Yes (n = 23)	No (n = 48)	
During the past month, how often did unexpected events upset you?	0.48 ± 0.8	0.33 ± 0.7	p = 0.19
During the past month, how often did you feel tense or stressed?	0.69 ± 0.7	0.48 ± 0.7	p = 0.22
During the past month, how often did you feel that things were working out well for you?	3.0 ± 0.0	3.1 ± 0.4	p = 0.25
During the past month, how often were you able to manage the irritations in your life?	3.1 ± 1.0	3.3 ± 0.8	p = 0.34
During the past month, how often did you feel unable to control important aspects of your life?	0.52 ± 0.7	0.27 ± 0.57	p = 0.12
During the past month, how often did you feel confident in handling your personal challenges?	3.7 ± 0.5	3.73 ± 0.5	p = 0.78
During the past month, how often did you feel unable to cope with all your responsibilities?	0.61 ± 0.8	0.44 ± 0.7	p = 0.33
During the past month, how often did you feel in control of things?	3.0 ± 0.2	2.9 ± 0.4	p = 0.45

During the past month, how often did you feel annoyed by situations beyond your control?	0.48 ± 0.8	0.71 ± 1.0	p = 0.34
During the past month, how often did you feel that your difficulties were accumulating to a level you could not manage?	0.65 ± 0.7	0.63 ± 0.8	p = 0.88
Total score for PSS	16.3 ± 2.7	15.9 ± 2.7	p = 0.64

Table 4: Predictors of metabolic syndrome among female nurses

Predictors	OR	95% CI	Significance (p value)
Age	1.36	0.99 - 1.86	0.055
Work experience	1.12	0.86 - 3.62	0.128
Years of rotational shift duty	1.32	1.02 - 1.86	0.047
Highly consumed meal: Dinner	1.38	0.96 - 5.12	0.752
Physical activity	0.43	0.06 - 2.96	0.391
Perceived stress scale score	0.97	0.75 - 1.25	0.799

DISCUSSION

This present study, conducted in the Patan district of Gujarat, aimed to study the prevalence of metabolic syndrome (MetS) and its associated risk factors among female nurses working rotational shifts. The prevalence of MetS in our study was found to be 32.4%, with a significant association observed with years of rotational shift duty. Our findings align with previous studies that have reported a higher occurrence of metabolic syndrome among healthcare workers engaged in shift work, emphasizing the occupational health risks posed by disrupted circadian rhythms.

Several studies have consistently demonstrated a high prevalence of MetS and its association with shift work. A large population-based study conducted in northern Sweden reported that female shift workers had a higher likelihood of being obese across all age groups and had higher triglyceride levels compared to their male counterparts. (18) Similarly, a study that examined nurses working in rotational shifts found that those in rotational shifts had a 3.34 times greater risk of developing metabolic syndrome. (19) These findings are in line with our study, where waist circumference, HDL cholesterol and triglycerides were found to be the most affected metabolic parameters among female nurses.

Our results also corroborate findings from studies conducted in Korea and Italy, which observed a significantly higher incidence of MetS among night shift healthcare workers. A cohort study by Itani et al found that shift work was a significant risk factor for MetS among male workers, (20) while another study from Korea reported similar associations. (21) A longitudinal study from Italy assessing the occurrence of metabolic syndrome among night-shift healthcare workers found a cumulative incidence of 9.0% over four years among night shift workers, compared to only 1.8% in those working fixed daytime shifts. The incidence rates were estimated at 2.9% per year for night shift workers and only 0.5% per year for daytime workers, further underscoring the metabolic burden associated with the shift work. (22)

Our current study identified a significant association between years of rotational shift duty and metabolic syndrome, with the risk increasing substantially among nurses who had been engaged in rotational shifts for more than 10 years. This finding is supported by previous studies that reported a strong link between long-term shift work—especially permanent night shifts—and dyslipidemia, characterized by elevated total cholesterol, triglycerides, and reduced HDL cholesterol. (23) A Brazilian cross-sectional study involving primary healthcare nurses also found that the most common metabolic abnormality among shift workers was low HDL cholesterol (24.4%), further reinforcing our observation that HDL cholesterol is a key parameter affected by shift work. (24)

The disturbance of the circadian rhythm due to shift work plays a crucial role in metabolic dysregulation. Circadian misalignment has been shown to affect key metabolic hormones such as leptin and ghrelin, which regulate appetite and satiety. (25) A reduction in leptin levels, observed in shift workers, diminishes the natural suppression of appetite, leading to higher food intake and subsequent weight gain. (26) Additionally, shift work has been linked to blunted post-meal suppression of ghrelin, further contributing to central obesity and metabolic disturbances. (27) The circadian clock is a key regulator of triglyceride and cholesterol metabolism, and previous studies have reported higher triglyceride levels among night shift workers when compared to day shift workers. (28-31) In our study, elevated triglyceride levels were observed in

25.4% of nurses, consistent with findings from previous research. (32-35)

Interestingly, despite the well-established role of stress in metabolic syndrome, our study did not find a significant association between perceived stress levels (measured by the Perceived Stress Scale) and metabolic syndrome. This is inconsistent with some prior studies that have linked chronic stress to metabolic dysregulation. (36-38)

CONCLUSION

This study demonstrates a high prevalence of metabolic syndrome (32.4%) among female nurses engaged in rotational shift work, with particularly frequent occurrences of low HDL and elevated random blood glucose. Age, total work experience, number of monthly night shifts, and duration of rotational shift work showed significant associations with metabolic syndrome, while perceived stress scores did not differ significantly between those with and without the syndrome. Years of rotational shift duty emerged as an independent predictor, suggesting that prolonged exposure to such schedules may contribute to adverse metabolic outcomes. These findings are consistent with existing literature indicating increased metabolic risk among shift-working healthcare personnel. Given the modest sample size and cross-sectional design, the results should be interpreted cautiously and cannot be generalized to all nurses; future studies with larger samples and a comparator group of fixed day-shift nurses are warranted to better delineate causality and underlying mechanisms.

The present study provides evidence that female nurses engaged in rotational shift work have high prevalence of metabolic syndrome. The findings align with global research demonstrating the adverse metabolic effects of shift work, particularly concerning dyslipidaemia, increased waist circumference, and elevated triglyceride levels. Given the essential role of nurses in healthcare, targeted interventions such as optimizing shift schedules is needed to mitigate the metabolic risks associated with shift work. Early screening and management of metabolic risk factors may contribute to improved health outcomes among nurses. However, given the limited sample size, these findings cannot be generalized. Future research should incorporate a comparator group of nurses working fixed daytime shifts to better delineate the impact of rotational shift work on metabolic health. Future mechanistic studies should further investigate the underlying mechanisms linking shift work and metabolic syndrome to develop effective preventive strategies.

DECLARATIONS

Ethical approval and consent to participate

The study was approved by the Institutional Human Ethics Committee and conducted in accordance with the principles of the Helsinki Declaration. All participants provided written informed consent prior to participation. Confidentiality and anonymity were ensured through data anonymization procedures, and participants were informed that they could withdraw from the study at any point without any consequences.

Consent for publication

Participants provided written consent allowing the use of interview data for publication. They were assured that their identities would remain confidential and would not be disclosed in any published material.

Availability of data and materials

The datasets generated and analysed during the study are not publicly accessible due to privacy considerations. However, they may be obtained from the corresponding author upon reasonable request.

RECOMMENDATION

Given the essential role of nurses in healthcare, targeted interventions such as optimizing shift schedules is needed to mitigate the metabolic risks associated with shift work. Early screening and management of metabolic risk factors may contribute to improved health outcomes among nurses. Workplace-based health promotion activities, including encouraging regular physical activity and facilitating access to counselling on diet and lifestyle, could be offered as supportive measures. Further research should evaluate the effectiveness and acceptability of such measures in improving metabolic outcomes among shift-working nurses in similar settings.

LIMITATION OF THE STUDY

This study has certain limitations, including the use of self-reported information, which may be prone to bias. The cross-sectional nature of the study also prevents drawing causal inferences. Additionally, because the study was conducted in a specific healthcare setting, the findings may not be fully generalizable to other populations or geographic contexts.

AUTHORS CONTRIBUTION

ST and AS were involved in the study conception, design, literature review, and data collection. Data analysis, interpretation, and drafting of the manuscript were carried out by ST, AS, and AK. AS

also revised the manuscript for important intellectual content. All authors reviewed and approved the final manuscript

CONFLICT OF INTEREST
The authors declare no conflicts of interest for this study.

DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS
The authors did not use any generative AI or AI-assisted technologies in the preparation of this manuscript and take full responsibility for the content of the publication.

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