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Shift work and cardiometabolic risk indices in healthcare workers: A cross-sectional study

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ABSTRACT

Aims: Healthcare workers in emergency and intensive care units often work demanding rotating night-shift schedules, which may adversely affect cardiometabolic health, yet data on derived cardiometabolic indices in this population are limited. This study aimed to compare cardiometabolic risk indices between rotating night-shift and daytime healthcare workers.

Methods: In this cross-sectional study, physicians and nurses working rotating night shifts in emergency and intensive care units were compared with daytime workers without rotating night shifts. Individuals with smoking, diabetes, hypertension, hypercholesterolemia, cardiovascular disease, thyroid disease, or chronic kidney disease were excluded. The primary endpoints were the atherogenic index of plasma (AIP) and the triglyceride-glucose (TyG) index, assessed for their independent association with shift-work status after accounting for age, sex, body mass index (BMI), and profession.

Results: A total of 281 healthcare workers were included [median age 32 years (interquartile range, 29-41); 39.9% male]: 121 in the shift-work group and 160 in the control group. The groups were comparable in age, sex, profession, and total working duration. The shift-work group had higher total cholesterol (196 vs. 181.5 mg/dL; p=0.008), triglycerides (107 vs. 89 mg/dL; p=0.002), AIP (0.30 vs. 0.23; p=0.008), TyG index (8.47 vs. 8.25; p=0.003), and TyG-BMI (206.5 vs. 193.1; p=0.003). Shift-work status was independently associated with both AIP [β=0.147; 95% confidence inteerval (CI) 0.048-0.245; p=0.004] and the TyG index (β=0.170; 95% CI 0.067-0.274; p=0.001), whereas BMI was not independently associated with either index.

Conclusion: Rotating night-shift healthcare workers had higher atherogenic and TyG indices than daytime workers, after adjustment for age, sex, and BMI and profession.

Introduction

Despite decades of progress in prevention, cardiovascular disease continues to account for more deaths than any other cause globally, which keeps the search for modifiable contributors a clinical priority (1). Attention has increasingly extended beyond conventional risk factors to the conditions under which people work, since certain occupational exposures meaningfully shape cardiometabolic risk. Rotating night-shift work is one such exposure that is both widespread and mechanistically credible (2). This concern was reinforced in 2025, when the American Heart Association issued a scientific statement identifying circadian disruption—commonly driven by night-shift schedules—as a meaningful contributor to cardiometabolic health and disease (3).

When work occurs during the biological night, the internal circadian clock falls out of step with the external light–dark

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cycle, producing a state known as circadian misalignment. This desynchronization has been tied to a range of metabolic disturbances, spanning dyslipidemia, disturbed glucose handling, elevated blood pressure, and weight gain (3,4). The pathways proposed to explain these effects include altered expression of clock genes, mistimed food intake, imbalance of the autonomic nervous system, and heightened oxidative stress and inflammation—processes that collectively favor a more atherogenic metabolic state (4,5). Consistent with these mechanisms, population studies have linked shift work to a greater burden of coronary heart disease, subclinical atherosclerosis, and type 2 diabetes (5,6).

Hospital staff are among the most heavily exposed to rotating night work, because emergency departments and intensive care units must remain staffed around the clock. Even so, most of the available evidence comes from industrial workforces that are largely male and physically active, which restricts how well those findings translate to a healthcare setting (5,7).

Standard lipid measurements capture only part of the atherogenic risk that accompanies metabolic dysregulation. For this reason, composite indices derived from routine laboratory values have gained traction as more sensitive indicators. The atherogenic index of plasma (AIP)—the base-10 logarithm of the triglyceride-to-high-density lipoprotein (HDL)-cholesterol ratio—mirrors the burden of small, dense low-density lipoprotein particles and shows a robust relationship with cardiovascular risk (8,9). The triglyceride-glucose (TyG) index, obtained from fasting triglyceride and glucose concentrations, is a well-established and readily available surrogate for insulin resistance (10,11). Because both indices require nothing beyond a standard fasting lipid and glucose panel, they lend themselves well to risk screening in workplace settings.

While separate links between shift work and each of these indices have been described, evidence drawn specifically from healthcare workers is scarce-particularly studies that examine several derived indices together while adjusting for body mass index (BMI) and additional confounders (10,12). Against this background, the present study aimed to compare AIP, the TyG index, and related cardiometabolic parameters in rotating night-shift healthcare workers from emergency and intensive care units against daytime colleagues without rotating night shifts, and to establish whether any differences were independent of age, sex, and BMI.

Methods

Study design and setting

This single-center cross-sectional study was conducted by retrospectively reviewing the occupational health surveillance and hospital information management system records of physicians and nurses employed at the Occupational Health and Safety Unit of a University of Health Sciences Türkiye, Gülhane Training and Research Hospital, in Ankara, Türkiye, between 1 January 2025 and 31 December 2025. Its design and reporting followed the strengthening the reporting of observational studies in epidemiology recommendations for cross-sectional studies.

Ethical approval

The protocol received approval from the Institutional Ethics Committee of University of Health Sciences Türkiye, Gülhane Training and Research Hospital (protocol no: 2026/130; decision date: 25 June 2026), and the study adhered to the principles of the Declaration of Helsinki (as revised in 2013). Because the analysis relied on de-identified data drawn retrospectively from a routine occupational health surveillance program, the ethics committee waived the requirement for informed consent.

Participants and group definition

Personnel were grouped according to their working schedule. The shift-work group consisted of physicians and nurses from the emergency department and intensive care units, all of whom followed a rotating night-shift schedule. Within these units, physicians typically worked between six and nine 24-hour on-call shifts per month and nurses between eight and nine, so that night duty recurred throughout the month. The control group comprised physicians and nurses from units that operated mainly during daytime hours without a rotating night-shift system (dermatology, biochemistry, and microbiology); in these units nurses worked approximately seven to eight shifts per month, whereas physicians had little or no night duty. Enrollment was restricted to physicians and nurses in both groups in order to reduce occupational heterogeneity. The control group was deliberately selected from units without a rotating night-shift schedule so that the presence or absence of rotating night-shift work constituted the defining difference between groups; restricting both groups to physicians and nurses further limited occupational heterogeneity unrelated to the shift schedule.

All eligible personnel in the defined units were screened, and those who met the criteria were included consecutively. A formal sample-size calculation was not undertaken, since the intention was to capture the entire eligible population.

Inclusion and exclusion criteria

Eligible participants were physicians and nurses aged 18 years or older working in the specified units. Individuals were excluded if they had a known diagnosis of, or were receiving treatment for, any condition capable of altering cardiometabolic parameters—namely diabetes mellitus, hypertension, hypercholesterolemia, coronary artery disease, myocardial infarction, heart failure, thyroid disease, or chronic kidney disease—as well as current smokers and those reporting alcohol use. These restrictions were intended to limit confounding from established metabolic and cardiovascular comorbidities (Figure 1).

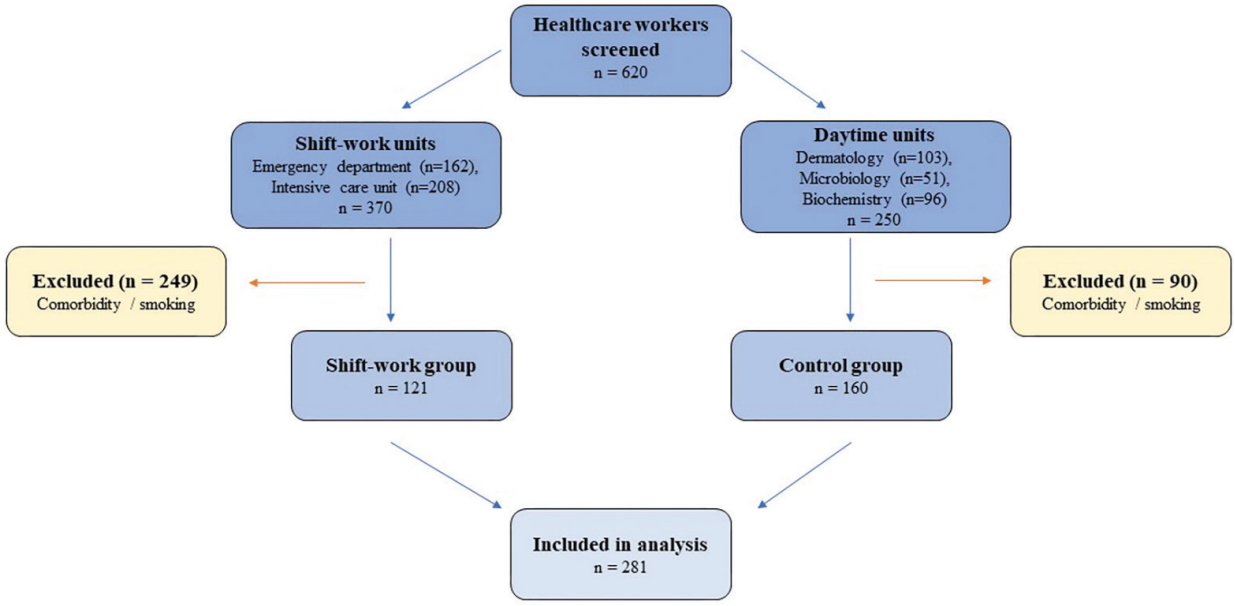


Figure 1. Flowchart of participant selection

Data collection and measurements

For each participant, demographic and occupational variables (age, sex, profession, and total working duration) were extracted from occupational health surveillance records. Body weight and height documented during routine surveillance were used to derive BMI as weight in kilograms divided by height in meters squared (kg/m^2).

As part of the surveillance program, venous blood had been drawn after an overnight fast of at least eight hours, and fasting plasma glucose, total cholesterol, HDL-cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides had been analyzed on a Cobas 8000 c702 analyzer (Roche Diagnostics, Mannheim, Germany), with LDL-C determined by a direct method. Only personnel with fasting glucose and lipid measurements performed within the one-year study period were included in the analysis.

Calculation of cardiometabolic ındices

Three derived indices were computed from the laboratory results. The AIP was defined as the base-10 logarithm of the triglyceride-to-HDL-C ratio [$\log_{10}$(TG/HDL-C)], with both values in mg/dL. The TyG index was calculated as in [fasting triglycerides (mg/dL) × fasting glucose (mg/dL)/2]. The TyG-BMI index was obtained by multiplying the TyG index by BMI.

Statistical Analysis

Analyses were conducted in IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was checked with the Shapiro-Wilk test; as these variables departed from normality, they are summarized as median [interquartile range (IQR)] and compared between groups with the Mann-Whitney U test. Categorical variables are expressed as frequency (percentage) and compared with the Pearson chi-square test. To assess whether shift-work status was independently related to the cardiometabolic indices (AIP and TyG), multivariable linear regression models were fitted with adjustment for age, sex, BMI, and profession; results are reported as standardized coefficients (β) with 95% confidence intervals (CIs), obtained from models fitted to standardized variables. Age, sex, and BMI were included a priori as well-recognized determinants of lipid- and glucose-based indices, and profession was added to account for the physician-nurse composition of the groups. Total working duration was not entered as a covariate because it was almost perfectly collinear with age (r=0.99), which would have introduced multicollinearity without adding independent information. Multicollinearity was assessed using variance inflation factors, and the normality of residuals was inspected. A two-sided p-value below 0.05 was considered as statistically significant.

Results

Study population

In total, 281 healthcare workers met the criteria and were analyzed: 121 were included in the shift-work group (60 physicians, 61 nurses) and 160 the control group (82 physicians, 78 nurses). The shift-work group was drawn from emergency department and intensive care unit staff following a rotating night-shift rota, whereas the control group comprised personnel from the dermatology, biochemistry, and microbiology units, who worked mainly daytime hours without such a rota. Individuals with smoking, hypertension, coronary artery disease, myocardial

Table 1. Demographic and clinical characteristics of the study groups

Variable	Shift-work group (n=121)	Control group (n=160)	p
Age (years), median (IQR)	32 (30-42)	32 (29-41)	0.225
BMI (kg/m^2), median (IQR)	24.3 (21.3-26.2)	23.1 (20.9-25.2)	**0.025**
Working duration (years), median (IQR)	8 (5-17)	8 (5-17)	0.400
Sex-male, n (%)	50 (41.3)	62 (38.8)	0.663
Profession-physician, n (%)	60 (49.6)	82 (51.2)	0.782

Continuous variables: Mann-Whitney U test; categorical variables: Pearson's chi-square test. Bold p-values are statistically significant (p<0.05). BMI: Body mass index, IQR: Interquartile range

infarction, heart failure, hypercholesterolemia, diabetes mellitus, thyroid disease, or chronic kidney disease had been excluded.

Demographic and clinical characteristics

The groups were similar in terms of age [median 32 (IQR 30-42) vs. 32 (29-41) years; p=0.225], proportion of men [50/121 (41.3%) vs. 62/160 (38.8%); p=0.663], physician-to-nurse ratio [physicians: 60/121 (49.6%) vs. 82/160 (51.2%) p=0.782], and total working duration [median 8 (5-17) vs. 8 (5-17) years; p=0.400]. BMI was slightly higher among shift workers [median 24.3 (21.3-26.2) vs. 23.1 (20.9-25.2) kg/m^2; p=0.025] (Table 1).

Cardiometabolic parameters

On bivariate comparison, shift workers had higher total cholesterol [median 196 (168-222) vs. 181.5 (160.5-209) mg/dL; p=0.008] and higher triglycerides [107 (75-163) vs. 89 (61-125) mg/dL; p=0.002] levels than controls. All three derived indices were also higher in the shift-work group: AIP [0.30 (0.11-0.52) vs. 0.23 (0.01-0.42); p=0.008], the TyG index [8.47 (8.09-8.84) vs. 8.25 (7.89-8.66); p=0.003], and TyG-BMI [206.5 (177.9-232.7) vs. 193.1 (168.2-213.4); p=0.003]. No significant between-group differences were observed for fasting glucose, HDL-cholesterol, or LDL-cholesterol (Table 2).

Multivariable analysis

Two linear regression models were built to test whether the link between shift work and the indices persisted after accounting for potential confounders. With adjustment for age, sex, BMI, and profession, shift-work status remained independently associated with both AIP (β=0.147; 95% CI 0.048-0.245; p=0.004) and the TyG index (β=0.170; 95% CI 0.067-0.274; p=0.001), reflecting higher values among shift workers. Male sex (AIP: β=0.437, 95% CI 0.331-0.544; TyG: β=0.323, 95% CI 0.212-0.435; both p<0.001) and older age (AIP: β=0.150, 95% CI 0.043-0.256, p=0.006; TyG: β=0.234, 95% CI 0.123-0.345, p<0.001) were also independent correlates of higher indices, whereas neither BMI (AIP: p=0.067; TyG: p=0.340) nor profession (AIP: p=0.833; TyG: p=0.243) reached significance. Total working duration was not entered because it was almost perfectly collinear with age (r=0.99). No multicollinearity was evident among the included covariates (all variance inflation factors <1.4), and the residuals were normally distributed (Table 3).

Discussion

In this cross-sectional study of hospital personnel, rotating night-shift staff from emergency and intensive care units displayed a distinctly more atherogenic cardiometabolic profile than colleagues working daytime hours without rotating night shifts. Triglyceride and total cholesterol concentrations, as well as the AIP, the TyG index, and TyG-BMI, were all higher in the shift-work group. Notably, the associations of shift work with AIP and with the TyG index persisted after accounting for age, sex, BMI, and profession, so they could not be attributed to adiposity, demographic imbalance, or occupational composition.

At the epidemiological level, the connection between shift work and unfavorable cardiovascular outcomes is by now firmly documented. Large prospective cohorts have linked rotating night-shift work to a higher risk of coronary heart disease (6), and a recent systematic review with dose-response meta-analysis of 23 cohorts reported that night-shift work raised the risk of both overall cardiovascular events and cardiovascular death (13). The present analysis extends this evidence by profiling the metabolic intermediaries that may sit on this pathway, using indices that are easy to obtain in a healthcare workforce. Focusing on emergency and intensive care staff is pertinent, since these units run continuously and impose some of the heaviest rotating night-shift demands in the hospital, whereas earlier occupational research has leaned heavily on industrial, mostly male, physically active cohorts (2,12). Our findings are consistent with a widening evidence base tying shift work to atherogenic dyslipidemia. Among 140 Jordanian hospital employees, those on night shifts had a higher AIP than day workers, accompanied by higher triglycerides and lower HDL-cholesterol (4). In a much larger cross-sectional sample of 53,053 Spanish workers, shift workers again showed less favorable atherogenic indices across several lipid ratios (12). A further study that jointly stratified participants by shift-work status and AIP found a stepwise rise in carotid intima-media thickness, the greatest subclinical atherosclerotic burden occurring in those carrying both factors, reinforcing the clinical weight of a raised AIP in shift-working groups (5). The triglyceride-led pattern in our data, higher triglycerides and AIP but comparable fasting glucose and HDL-cholesterol, echoes the dyslipidemic signature reported in those cohorts and fits the expected circadian dysregulation of lipid handling (3,4).

Table 2. Comparison of cardiometabolic parameters between groups

Parameter	Shift-work group (n=121)	Control group (n=160)	p
Fasting glucose (mg/dL)	89 (83-94)	88 (83-95)	0.976
Total cholesterol (mg/dL)	196 (168-222)	181.5 (160.5-209)	**0.008**
LDL-cholesterol (mg/dL)	111 (95-140)	105.5 (84-129.3)	0.053
HDL-cholesterol (mg/dL)	51 (43-63)	55 (46-64.3)	0.156
Triglyceride (mg/dL)	107 (75-163)	89 (61-125)	**0.002**
AIP	0.30 (0.11-0.52)	0.23 (0.01-0.42)	**0.008**
TyG	8.47 (8.09-8.84)	8.25 (7.89-8.66)	**0.003**
TyG-BMI	206.5 (177.9-232.7)	193.1 (168.2-213.4)	**0.003**

Values are median (interquartile range). Mann-Whitney U test. Bold p-values are statistically significant (p<0.05). AIP: Atherogenic index of plasma, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TyG: Triglyceride-glucose index, BMI: Body mass index

Table 3. Multivariable linear regression analysis for AIP and TyG

Predictor	AIP model				TyG model			
	B (95% CI)	SE	β (95% CI)	p	B (95% CI)	SE	β (95% CI)	p
Group (shift-work)	0.088 (0.029-0.147)	0.030	0.147 (0.048-0.245)	**0.004**	0.194 (0.077-0.312)	0.060	0.170 (0.067-0.274)	**0.001**
Age	0.005 (0.001-0.008)	0.002	0.150 (0.043-0.256)	**0.006**	0.014 (0.007-0.021)	0.003	0.234 (0.123-0.345)	**<0.001**
Sex	0.266 (0.202-0.331)	0.033	0.437 (0.331-0.544)	**<0.001**	0.372 (0.244-0.500)	0.065	0.323 (0.212-0.435)	**<0.001**
BMI	0.009 (-0.001-0.019)	0.005	0.107 (-0.007-0.222)	0.067	0.009 (-0.010-0.029)	0.010	0.058 (-0.062-0.178)	0.340
Profession	-0.007 (-0.066-0.053)	0.030	-0.011 (-0.111-0.089)	0.833	-0.070 (-0.188-0.047)	0.060	-0.062 (-0.167-0.042)	0.243
R^2 (adjusted R^2)	**0.327 (0.315)**				**0.264 (0.250)**			

Multivariable linear regression with adjustment for age, sex, BMI, and profession. B: Unstandardized regression coefficient; SE: Standard error; β, standardized regression coefficient; CI: Confidence interval. Group coded 1=shift-work, 0=control; a positive coefficient indicates a higher index in the shift-work group. Sex coded 0=female, 1=male; profession coded 0=physician, 1=nurse. Total working duration was excluded owing to near-perfect collinearity with age (r=0.99). All variance inflation factors were <1.4, and residuals were normally distributed. Bold p-values are statistically significant (p<0.05). AIP: Atherogenic index of plasma, TyG: Triglyceride-glucose index, BMI: Body mass index

The higher TyG index we observed among shift workers is likewise in keeping with earlier work. In over 3,000 Korean chemical-plant employees, shift work was independently linked to a higher TyG index after controlling for age, employment length, obesity, lifestyle, and comorbidity (10). The TyG index has drawn growing interest as a cardiovascular marker, with large meta-analyses showing that higher values track with an increased risk of major adverse cardiovascular events and mortality, independent of conventional risk factors and across both diabetic and non-diabetic groups (14). However, it is important to emphasize that the TyG index is only an indirect proxy computed from fasting triglyceride and glucose; it does not measure insulin resistance itself, which would require fasting insulin-based approaches such as the homeostatic model assessment of insulin resistance (HOMA-IR) or the hyperinsulinemic-euglycemic clamp (11,15). Even though the TyG index reportedly matches, and sometimes exceeds, HOMA-IR for predicting incident diabetes (15), our results are best read as signaling a more atherogenic and possibly insulin-resistant phenotype rather than as direct proof of insulin resistance, an important caveat, since glucose-based measures alone cannot confirm insulin resistance.

Several plausible biological routes could account for these associations. Circadian misalignment provoked by night work unsettles the timing of metabolic processes, with downstream effects on clock-gene expression, hepatic lipid synthesis and clearance, and glucose regulation (3,16). Consuming food during the biological night, an almost unavoidable feature of night shifts, drives hepatic triglyceride production and hampers lipid clearance, and meal timing itself influences metabolic health independently of how many calories are eaten (3). Layered onto this are autonomic imbalance, greater oxidative stress, and a pro-inflammatory milieu, including raised C-reactive protein and interleukin-6, all repeatedly noted in shift workers and mechanistically tied to the onset and advance of atherosclerosis (2,13). The 2025 American Heart Association scientific statement gave formal recognition to these circadian pathways as pertinent to cardiometabolic disease, naming night-shift work as a leading

source of circadian disruption and highlighting how timely it is to examine circadian-related occupational exposures (3).

One noteworthy aspect of our findings is that the shift-work association held even though BMI was not independently associated with either index in multivariable models. The shift-work group was modestly heavier in bivariate terms, yet that difference did not, on its own, explain the raised indices once shift work, age, sex, and profession were in the model. This implies that the atherogenic signal of shift work here was not simply a by-product of greater body weight but may stem from more direct metabolic effects of circadian disruption, again consistent with the AHA statement, which notes that circadian misalignment can influence metabolism through routes partly independent of adiposity (3).

These findings may have implications relevance for occupational health practice. Both AIP and the TyG index can be calculated without additional laboratory testing from the fasting lipid and glucose panel already collected during periodic surveillance of shift workers (8,10). Building these indices into the routine monitoring of emergency and intensive care staff could help flag individuals with an adverse cardiometabolic profile earlier, prompting targeted lifestyle counseling, adjustment of shift rotas where practicable, and closer follow-up. Because AIP and TyG capture atherogenic burden more sensitively than any single conventional lipid value, computing them adds meaningful risk information for little effort (8,9). In practical terms, a shift worker whose AIP or TyG index is elevated despite a normal-appearing standard lipid panel could be identified for earlier preventive intervention, allowing occupational health services to prioritize a genuinely higher-risk subgroup within an otherwise young and apparently healthy workforce. Given the continuous and largely non-negotiable nature of night-shift work in critical-care settings, such low-cost stratification may be especially valuable for this population.

Study Limitations

Some limitations should be acknowledged. First, the cross-sectional design rules out causal inference; the temporal ordering of shift work and the metabolic findings cannot be determined, and the results should be read as associations rather than cause-and-effect. Second, the study was single-center and confined to physicians and nurses, which may limit generalizability to other healthcare roles, institutions, and shift systems. Third, although the control group was drawn from units without a rotating night-shift rota, the two groups may also differ in occupational characteristics such as physical activity, workload intensity, and acute occupational stress; several of these factors are intermediate components of the pathway linking night-shift work to cardiometabolic risk rather than independent confounders, but their contribution could not be disentangled in the present design. Fourth, several behavioral factors of potential relevance, including physical activity, diet (particularly nighttime eating), sleep duration and quality, and socioeconomic status, were not captured in the retrospective surveillance dataset, so residual confounding cannot be excluded; we mitigated this by excluding established metabolic and cardiovascular comorbidities and by adjusting for age, sex, BMI, and profession, but unmeasured lifestyle influences may persist. Prospective studies with structured collection of physical activity, dietary patterns, and sleep would help confirm and extend these findings. Fifth, insulin resistance was not measured directly, the TyG index serving only as an indirect surrogate, and fasting insulin was unavailable. Finally, although the typical monthly shift load of each unit was known and is described above, exposure was classified categorically by the presence or absence of a rotating night-shift schedule rather than by an individually quantified count of night shifts or a measure of shift intensity; this relatively coarse classification would tend to bias comparisons toward the null, so the true effect may be larger than estimated. Future studies that record individual shift frequency and intensity would allow a more precise dose-response assessment.

Conclusion

In conclusion, rotating night-shift healthcare workers in emergency and intensive care units showed a more atherogenic cardiometabolic profile than daytime workers, with higher AIP and TyG indices that persisted after adjustment for age, sex, BMI, and profession. These findings reinforce the evidence that circadian disruption associated with shift work relates to adverse metabolic markers and support incorporating simple, lipid-based atherogenic and metabolic indices into the occupational health surveillance of shift-working healthcare personnel. Prospective studies with direct measures of insulin resistance, detailed behavioral data, and quantified shift exposure are needed to confirm these associations and clarify the mechanisms involved.

Ethics

Ethics Committee Approval: The protocol received approval from the Institutional Ethics Committee of University of Health Sciences Türkiye, Gülhane Training and Research Hospital (protocol no: 2026/130; decision date: 25 June 2026), and the study adhered to the principles of the Declaration of Helsinki (as revised in 2013).

Informed Consent: Because the analysis relied on de-identified data drawn retrospectively from a routine occupational health surveillance program, the ethics committee waived the requirement for informed consent.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.Ö., Concept: S.Ö., Design: S.Ö., Data Collection or Processing: S.Ö., Analysis or

Interpretation: S.Ö., M.T.K., Literature Search: S.Ö., Writing: S.Ö., M.T.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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