

Health Burden of Night-Shift Work Among Polysomnography Technologists in India: A Cross-Sectional Study

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Abstract

Introduction: Polysomnography technologists perform overnight sleep studies requiring continuous patient monitoring, technical management of diagnostic equipment, and sustained attention. Although night-shift work has been associated with adverse health outcomes among healthcare workers, the occupational health burden among polysomnography technologists remains poorly characterized in India. This study evaluated sleep quality, excessive daytime sleepiness, burnout-related symptoms, musculoskeletal symptoms, and selected cardiometabolic indicators and examined their associations with years of night-shift work experience.

Methods: This cross-sectional observational study used an online structured questionnaire distributed through professional groups to polysomnography technologists working in private hospitals and sleep centers in South India. Participants were graduates with at least six months of night-shift experience. Of 196 responses, 16 were excluded for less than six months of night-shift experience and 30 for incomplete questionnaires, leaving 150 participants for analysis. The questionnaire included the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), Copenhagen Burnout Inventory (CBI), and musculoskeletal assessment. Height and weight were measured by participants. Blood pressure was manually assessed, while fasting blood glucose and glycated hemoglobin (HbA1c) were obtained from recent laboratory reports. Poor sleep quality was defined as PSQI >5 and excessive daytime sleepiness as ESS >10. The CBI was analyzed continuously and categorized operationally as 0-49, 50-74, and 75-100. Years of night-shift work experience were analyzed as a continuous exposure and categorized as ≤5 versus >5 years. Multivariable logistic regression was adjusted for age, sex, and BMI.

Results: Mean age was 29.97 ± 4.43 years, and BMI was 24.16 ± 3.19 kg/m². Mean PSQI, ESS, and CBI scores were 7.09 ± 2.95 , 9.20 ± 3.39 , and 45.99 ± 20.95 , respectively. Poor sleep quality occurred in 97 (64.7%), excessive daytime sleepiness in 56 (37.3%), and musculoskeletal symptoms in 126 (84.0%). CBI scores were categorized as 0-49 in 86 (57.3%), 50-74 in 48 (32.0%), and 75-100 in 16 (10.7%). Hypertension-range blood pressure was identified in 21 (14.0%) and prediabetes in 11 (7.3%). Each additional year of night-shift work experience was associated with higher odds of poor sleep quality (adjusted odds ratio (aOR): 1.433, 95% CI: 1.118-1.835), excessive daytime sleepiness (aOR: 1.205, 95% CI: 1.001-1.450), CBI ≥50 (aOR: 1.810, 95% CI: 1.350-2.428), musculoskeletal symptoms (aOR: 1.372, 95% CI: 1.003-1.878), lower-back symptoms (aOR: 1.296, 95% CI: 1.051-1.598), neck symptoms (aOR: 1.272, 95% CI: 1.043-1.552), and hypertension-range blood pressure (aOR: 1.387, 95% CI: 1.052-1.829). No significant associations were observed with shoulder symptoms or prediabetes.

Conclusion: Polysomnography technologists reported frequent poor sleep quality, excessive daytime sleepiness, burnout-related symptoms, and musculoskeletal symptoms. More years of night-shift work experience were associated with several adverse health outcomes after adjustment for age, sex, and BMI. These findings should be interpreted cautiously given the cross-sectional design and potential residual confounding. Prospective multicenter studies are warranted.

Categories: Occupational Health, Pulmonology, Epidemiology/Public Health

Keywords: cross-sectional study, daytime sleepiness, musculoskeletal pain, night-shift work, occupational burnout, occupational health, polysomnography technologists, shift work, sleep medicine, sleep quality

Introduction

Polysomnography technologists play an essential role in sleep medicine by preparing patients for overnight polysomnography, applying and monitoring multiple physiological sensors, maintaining signal quality, identifying technical problems, and continuously observing patients during sleep studies. Because polysomnography is predominantly performed overnight, these professionals are routinely exposed to night-shift duties and disruption of normal sleep-wake schedules. Unlike workers whose schedules are exclusively daytime-based, polysomnography technologists may repeatedly perform overnight duties as part of their routine occupational schedule, with the frequency and timing of night duties varying according to

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institutional staffing and rostering practices.

Night-shift work can adversely affect circadian alignment, sleep quality, daytime alertness, and overall health. Evidence from healthcare and other occupational populations has demonstrated associations between shift work and sleep disturbances, with healthcare professionals representing a particularly vulnerable occupational group [1,2]. Systematic reviews have also reported associations between shift work and adverse cardiometabolic outcomes, including alterations in blood pressure and hypertension [1,3]. These effects may be influenced by cumulative exposure, sleep disruption, recovery time, and individual and workplace factors.

The occupational burden of night work extends beyond sleep and cardiometabolic health. Healthcare workers exposed to demanding schedules may experience fatigue, reduced recovery, psychological strain, and burnout. Burnout and sleep disturbances may also interact, with inadequate sleep and fatigue potentially contributing to impaired recovery and psychological strain [4]. Musculoskeletal symptoms are common among healthcare professionals and may be related to physical demands, sustained or constrained working positions, repetitive activities, and workplace ergonomics [5,6]. For polysomnography technologists, overnight monitoring may involve prolonged sitting, repeated patient assistance, equipment handling, and limited opportunities for movement, potentially contributing to musculoskeletal symptoms.

Despite increasing evidence regarding the health effects of shift work among healthcare professionals, limited research has specifically examined polysomnography technologists. This represents an important occupational health gap because polysomnography technologists perform specialized overnight diagnostic procedures that combine continuous physiological signal monitoring, technical troubleshooting, and patient assistance, potentially creating a distinct pattern of occupational demands compared with other healthcare professionals. These professionals may accumulate substantial night-shift exposure over several years. Their occupational health is particularly relevant to sleep medicine services because adequate alertness, concentration, and physical well-being are important for maintaining the quality and safety of overnight patient monitoring.

The present study therefore evaluated the occupational health burden associated with night-shift work among polysomnography technologists in India. We assessed sleep quality, excessive daytime sleepiness, burnout-related symptoms, musculoskeletal symptoms, hypertension-range blood pressure, and prediabetes and examined whether the number of years of night-shift work experience was associated with these outcomes. We hypothesized that a greater number of years of night-shift work experience would be associated with poorer sleep quality, greater daytime sleepiness and burnout-related symptoms, a higher prevalence of musculoskeletal symptoms, and adverse cardiometabolic indicators.

Materials And Methods

Study design and participants

This cross-sectional, observational study was conducted among polysomnography technologists working in private hospitals and sleep centers in South India. Participants were recruited electronically through professional groups and contacts associated with private hospitals and sleep centers. The Google Forms (Google LLC, Mountain View, California, USA) survey was open for responses from December 5, 2025, to August 15, 2026. The exact number of participating institutions and the state-wise distribution of participants were not systematically documented.

A non-probability convenience sampling approach was used to recruit eligible participants through accessible professional groups and contacts associated with private hospitals and sleep centers. Participation was voluntary, and no random selection of individuals or institutions was performed. This recruitment strategy may have introduced selection bias, as technologists who were more engaged with professional networks or more interested in occupational health may have been more likely to participate. Consequently, the sample may not fully represent all polysomnography technologists working in India.

Participants were eligible if they were graduates working as polysomnography technologists and had at least six months of experience performing night-shift duties. Participation was voluntary, and electronic informed consent was obtained before completion of the questionnaire. A total of 196 responses were received. Sixteen respondents were excluded because they had less than six months of night-shift experience, and 30 were excluded because of incomplete questionnaires. Therefore, 150 participants who fulfilled the eligibility criteria and provided complete responses were included in the final analysis.

Occupational and night-shift characteristics

Night duties among the participants were intermittent rather than continuous throughout the week. Participants generally performed approximately two to four overnight sleep studies per week, although the frequency and scheduling of night duties varied according to institutional staffing patterns. Some institutions used rotational schedules, whereas others assigned night duties according to institutional rosters.

A typical polysomnography study required approximately seven hours. When patient connection, monitoring, disconnection, and associated technical responsibilities were considered, the overall duty related to a sleep study generally extended to approximately 8–10 hours. An off or recovery day was provided following a sleep study according to the institutional duty schedule.

Participants also performed routine daytime duties of approximately eight hours. Depending on the institutional arrangement, a sleep-study duty could be added to the routine daytime schedule. Most participating institutions had one sleep laboratory, although the organizational structure varied between hospitals and sleep centers.

Years of night-shift work experience were recorded as the total number of years performing night duties. This measure was analyzed as a continuous exposure in the primary analyses to preserve information across the observed range of experience and avoid unnecessary categorization. For secondary analyses, participants were categorized into groups with ≤ 5 years and > 5 years of night-shift work experience to facilitate comparison between participants with shorter and longer experience. This cutoff was used as an analytical grouping rather than a clinically validated threshold. The primary conclusions were therefore based on analyses treating years of night-shift work experience as a continuous exposure, with categorical analyses serving as supplementary comparisons.

Data collection

Data were collected using a structured electronic questionnaire administered through Google Forms (Google LLC, Mountain View, CA, USA; web-based application). The questionnaire was distributed through professional groups and included demographic, occupational, sleep-related, psychological, musculoskeletal, anthropometric, and cardiometabolic variables. Demographic variables included age and sex. Occupational variables included total work experience and years of night-shift work experience. Participants also provided information regarding their work setting and night-duty pattern.

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) [7]. The PSQI provides a global score reflecting subjective sleep quality and related sleep characteristics. A global PSQI score > 5 was considered indicative of poor sleep quality [7]. Daytime sleepiness was assessed using the Epworth Sleepiness Scale (ESS) [8]. An ESS score > 10 was considered indicative of excessive daytime sleepiness [8].

Burnout-related symptoms were assessed using the Copenhagen Burnout Inventory (CBI). The CBI provides a score ranging from 0 to 100, with higher scores indicating greater burnout-related symptoms [9]. CBI scores were analyzed primarily as a continuous variable. For descriptive analysis, scores were additionally classified according to the operational categories used in the study questionnaire: 0–49, 50–74, and 75–100. For secondary binary analysis, CBI ≥ 50 represented the combined 50–74 and 75–100 categories. These categories were treated as operational classifications used in this study and were not considered universally validated diagnostic thresholds for burnout. Musculoskeletal symptoms were assessed using the Nordic Musculoskeletal Questionnaire framework [10]. Participants reported musculoskeletal symptoms experienced during the preceding six months. The analysis focused on overall musculoskeletal symptoms and symptoms involving the lower back, neck, and shoulders.

Anthropometric assessment

Height and weight were measured by the participants and used to calculate body mass index (BMI) in kilograms per square meter (kg/m^2). BMI was included as a continuous variable in the primary multivariable analyses.

Blood pressure assessment

Blood pressure was manually measured by participants using a standard blood pressure measurement device. Blood pressure values were categorized according to the study-defined ranges: normal (< 120 mmHg systolic and < 80 mmHg diastolic), elevated (120–129 mmHg systolic and < 80 mmHg diastolic), stage 1 (130–139 mmHg systolic or 80–89 mmHg diastolic), and stage 2 (≥ 140 mmHg systolic or ≥ 90 mmHg diastolic). For analysis, participants meeting stage 1 or stage 2 criteria were classified as having hypertension-range blood pressure. As blood pressure was measured by participants and the classification was based on the reported measurement, this outcome should be interpreted as a screening-level classification rather than a clinical diagnosis of hypertension. Clinical diagnosis requires appropriate assessment and confirmation by a healthcare professional.

Glycemic assessment

Fasting plasma glucose (FPG) and glycated hemoglobin (HbA1c) values were obtained from recent laboratory reports provided by the participants. Glycemic status was classified as normal when FPG was < 100 mg/dL and HbA1c was $< 5.7\%$, prediabetes when FPG was 100–125 mg/dL and/or HbA1c was 5.7–6.4%, and diabetes when FPG was ≥ 126 mg/dL and/or HbA1c was $\geq 6.5\%$. Participants meeting diabetes criteria were not included in the prediabetes category.

Ethical considerations

The study was reviewed and approved by the Father Muller Institutional Ethics Committee (FMIEC), Father Muller Medical College Hospital, Mangaluru, Karnataka, India (Ref No. FMIEC/CCM/918/2025; Protocol No. 860/2025) on November 19, 2025. Electronic informed consent was obtained from all participants through the Google Forms survey before participation. Participation was voluntary, and participants could choose not to participate before submitting the questionnaire.

Sample size

The planned sample size was 150 participants. The sample size was estimated assuming a 50% prevalence of poor sleep quality, with a 95% confidence level and an 8% margin of error. The final analytical sample consisted of 150 eligible participants with complete questionnaires, corresponding to the prespecified sample size. The approved protocol specifies the same sample-size assumptions.

Statistical analysis

Data were analyzed using descriptive and inferential statistical methods. Continuous variables were summarized using mean $\pm$ standard deviation, while categorical variables were summarized as frequencies and percentages. Participants were compared according to years of night-shift work experience, categorized as ≤ 5 years and >5 years for secondary analyses. Continuous variables were compared between the two exposure groups using independent-samples t-tests, and categorical variables were compared using Pearson's chi-square test. Effect sizes were reported as Cohen's d for continuous between-group comparisons and Cramer's V for categorical associations.

The primary analyses examined years of night-shift work experience as a continuous exposure. Multivariable logistic regression was used to evaluate the association between each additional year of night-shift work experience and binary outcomes, including poor sleep quality, excessive daytime sleepiness, CBI ≥ 50 , musculoskeletal symptoms, lower-back symptoms, neck symptoms, shoulder symptoms, hypertension-range blood pressure, and prediabetes. Each multivariable regression model was adjusted for age, sex, and BMI to estimate the association between years of night-shift work experience and the outcome while accounting for these variables. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) and Wald chi-square statistics were reported.

Secondary logistic regression analyses examined years of night-shift work experience as a categorical exposure (≤ 5 versus >5 years), with adjustment for age, sex, and BMI. Linear regression analyses were performed to evaluate associations between years of night-shift work experience and continuous PSQI, ESS, and CBI scores after adjustment for age, sex, and BMI. Regression coefficients (β), 95% CIs, t-statistics, and model R^2 values were reported. Spearman rank correlation analysis was performed to evaluate the relationships between years of night-shift work experience and PSQI, ESS, and CBI scores, as well as the relationships among the principal sleep and burnout-related measures. Spearman correlation coefficients (ρ) and corresponding p-values were reported.

Age, total work experience, and years of night-shift work experience were strongly correlated in the study population. Total work experience was therefore excluded from the primary multivariable models to reduce multicollinearity and minimize the potential for unstable parameter estimates. The primary models were adjusted for age, sex, and BMI. Other potentially relevant factors, including habitual sleep duration, caffeine and stimulant use, physical activity, psychosocial stressors, and detailed shift-scheduling characteristics, were not comprehensively assessed and could not be included consistently in the adjusted models. Residual confounding may therefore remain. Statistical significance was defined as a two-sided p-value <0.05 . Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA).

Results

Participant characteristics

A total of 196 responses were received. Sixteen responses were excluded because the respondents had less than six months of night-shift experience, and 30 were excluded because of incomplete questionnaires. The final analysis included 150 eligible participants with complete data.

The mean age of the participants was 29.97 ± 4.43 years, and the mean BMI was 24.16 ± 3.19 kg/m². The mean total work experience was 8.05 ± 4.42 years, and the mean years of night-shift work experience were 6.37 ± 4.32 years. Of the 150 participants, 98 (65.3%) were male and 52 (34.7%) were female (Table 1). The mean PSQI score was 7.09 ± 2.95 , the mean ESS score was 9.20 ± 3.39 , and the mean CBI score was 45.99 ± 20.95 (Table 1).

Variable	Value
Age, years	29.97 ± 4.43
BMI, kg/m ²	24.16 ± 3.19
Total work experience, years	8.05 ± 4.42
Night-shift experience, years	6.37 ± 4.32
Male, n (%)	98 (65.3%)
Female, n (%)	52 (34.7%)
PSQI score	7.09 ± 2.95
ESS score	9.20 ± 3.39
CBI score	45.99 ± 20.95
Poor sleep quality (PSQI >5), n (%)	97 (64.7%)
Excessive daytime sleepiness (ESS >10), n (%)	56 (37.3%)
CBI 0-49, n (%)	86 (57.3%)
CBI 50-74, n (%)	48 (32.0%)
CBI 75-100, n (%)	16 (10.7%)
CBI ≥50, n (%)	64 (42.7%)
Musculoskeletal symptoms, n (%)	126 (84.0%)
Lower-back symptoms, n (%)	89 (59.3%)
Neck symptoms, n (%)	68 (45.3%)
Shoulder symptoms, n (%)	45 (30.0%)
Hypertension-range blood pressure, n (%)	21 (14.0%)
Prediabetes, n (%)	11 (7.3%)

TABLE 1: Participant characteristics and principal outcomes (n=150)

Continuous variables are presented as mean ± standard deviation (SD), and categorical variables are presented as number (percentage). BMI, body mass index; PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CBI, Copenhagen Burnout Inventory.

Sleep quality, daytime sleepiness, burnout, and musculoskeletal symptoms

Poor sleep quality, defined as a PSQI score >5, was present in 97 participants (64.7%). Excessive daytime sleepiness, defined as an ESS score >10, was observed in 56 participants (37.3%). The distribution of CBI scores showed that 86 participants (57.3%) had scores of 0-49, 48 (32.0%) had scores of 50-74, and 16 (10.7%) had scores of 75-100 (Figure 1). Thus, 64 participants (42.7%) had a CBI score ≥50 in the secondary binary analysis.

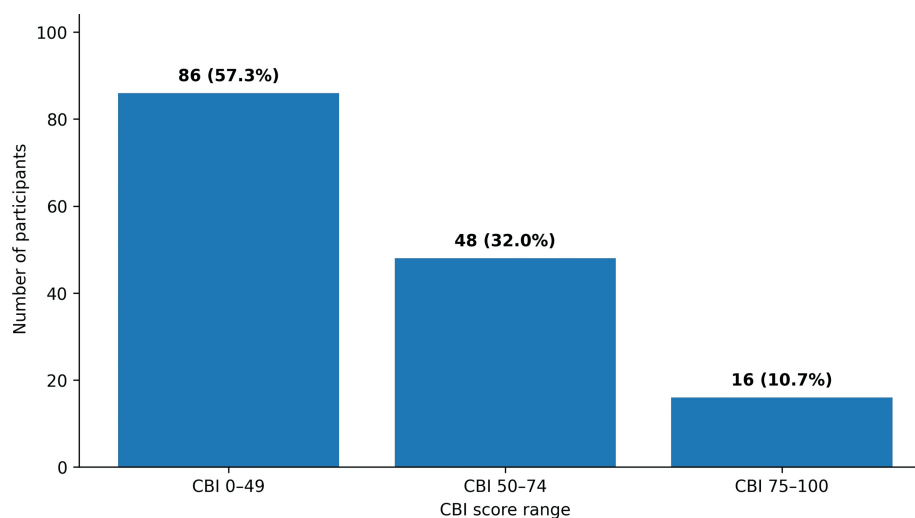


FIGURE 1: Distribution of Copenhagen Burnout Inventory (CBI) scores among polysomnography technologists (n=150)

Note: Values are presented as number (percentage). CBI, Copenhagen Burnout Inventory.

Musculoskeletal symptoms were reported by 126 participants (84.0%). Lower-back symptoms were reported by 89 (59.3%), neck symptoms by 68 (45.3%), and shoulder symptoms by 45 (30.0%). Hypertension-range blood pressure was present in 21 participants (14.0%), while 11 (7.3%) met the study criteria for prediabetes (Figure 2).

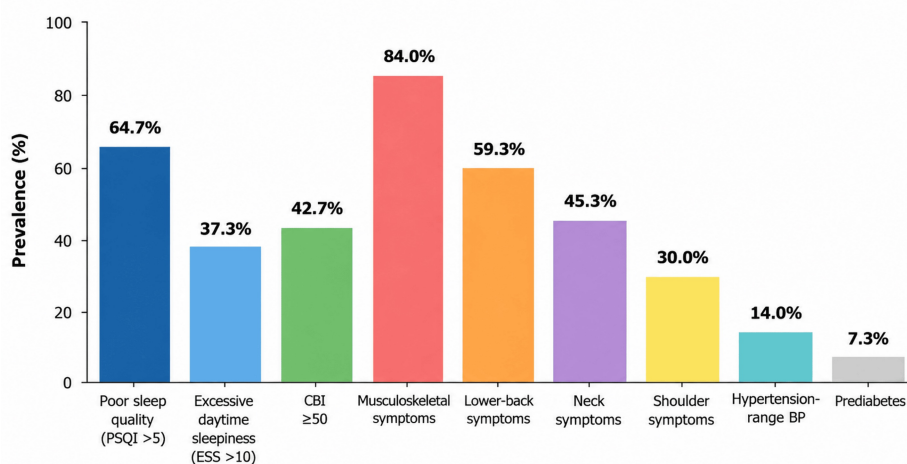


FIGURE 2: Prevalence of major occupational health outcomes among polysomnography technologists (n=150)

Note: Values are presented as percentages of participants. PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CBI, Copenhagen Burnout Inventory.

Comparison according to years of night-shift work experience

Participants were categorized into those with ≤5 years and >5 years of night-shift experience. Sixty-eight participants (45.3%) had ≤5 years of night-shift experience, while 82 (54.7%) had >5 years. Participants with >5 years of night-shift work experience had higher mean age, BMI, total work experience, and years of night-shift work experience than those with ≤5 years (Table 2).

Variable	≤5 years (n=68)	>5 years (n=82)	Test statistic	p-value	Effect size
Age, years	26.44 ± 2.74	32.90 ± 3.27	t = -12.948 (df=148)	<0.001	Cohen's d = -2.124
BMI, kg/m ²	23.18 ± 2.97	24.97 ± 3.15	t = -3.559 (df=148)	<0.001	Cohen's d = -0.584
Total work experience, years	4.26 ± 2.41	11.20 ± 3.00	t = -15.359 (df=148)	<0.001	Cohen's d = -2.519
Night-shift experience, years	2.43 ± 1.48	9.63 ± 2.96	t = -18.274 (df=148)	<0.001	Cohen's d = -2.997
PSQI score	4.82 ± 1.84	8.96 ± 2.31	t = -11.946 (df=148)	<0.001	Cohen's d = -1.959
ESS score	7.60 ± 3.24	10.52 ± 2.92	t = -5.806 (df=148)	<0.001	Cohen's d = -0.952
CBI score	31.01 ± 13.46	58.41 ± 17.70	t = -10.493 (df=148)	<0.001	Cohen's d = -1.721

TABLE 2: Comparison of participants according to years of night-shift work experience

Continuous variables are presented as mean ± standard deviation (SD). Between-group comparisons were performed using independent-samples t-tests. Test statistics are reported as t values with 148 degrees of freedom. Cohen's d represents the standardized mean difference. Negative values reflect the direction of calculation (≤5 years minus >5 years). BMI, body mass index; PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CBI, Copenhagen Burnout Inventory.

The mean age was 26.44 ± 2.74 years in the ≤5-year group and 32.90 ± 3.27 years in the >5-year group (t=-12.948, df=148, p<0.001). Mean BMI was 23.18 ± 2.97 versus 24.97 ± 3.15 kg/m², respectively (t=-3.559, df=148, p<0.001). Mean PSQI scores were significantly higher among participants with >5 years of night-shift exposure (8.96 ± 2.31) than among those with ≤5 years (4.82 ± 1.84; t=-11.946, df=148, p<0.001). Similarly, mean ESS scores were 10.52 ± 2.92 versus 7.60 ± 3.24 (t=-5.806, df=148, p<0.001), and mean CBI scores were 58.41 ± 17.70 versus 31.01 ± 13.46 (t=-10.493, df=148, p<0.001), respectively.

Association between years of night-shift work experience and occupational health outcomes

In crude analyses comparing participants with >5 years versus ≤5 years of night-shift experience, the odds of poor sleep quality were higher among participants with >5 years of night-shift work (OR: 18.10, $\chi^2=51.789$, df=1, p<0.001, Cramer's V=0.588), as were the odds of excessive daytime sleepiness (OR: 4.66, $\chi^2=17.642$, df=1, p<0.001, Cramer's V=0.343) and CBI ≥50 (OR: 32.32, $\chi^2=63.413$, df=1, p<0.001, Cramer's V=0.650). Higher odds of overall musculoskeletal symptoms were also observed (OR: 11.77, $\chi^2=20.499$, df=1, p<0.001, Cramer's V=0.370), as well as lower-back symptoms (OR: 5.36, $\chi^2=22.947$, df=1, p<0.001, Cramer's V=0.391), neck symptoms (OR: 10.05, $\chi^2=38.475$, df=1, p<0.001, Cramer's V=0.506), and shoulder symptoms (OR: 3.67, $\chi^2=11.319$, df=1, p<0.001, Cramer's V=0.275). Higher odds of hypertension-range blood pressure were also observed (OR: 21.61, $\chi^2=16.219$, df=1, p<0.001, Cramer's V=0.329). The association with prediabetes was not statistically significant (OR: 2.34, $\chi^2=1.562$, df=1, p=0.211, Cramer's V=0.102) (Table 3).

Outcome	≤5 years n/N (%)	>5 years n/N (%)	Crude OR	χ^2 (df=1)	p-value	Cramer's V
Poor sleep quality	23/68 (33.8%)	74/82 (90.2%)	18.1	51.789	<0.001	0.588
Excessive daytime sleepiness	13/68 (19.1%)	43/82 (52.4%)	4.66	17.642	<0.001	0.343
CBI ≥50	5/68 (7.4%)	59/82 (72.0%)	32.32	63.413	<0.001	0.65
Musculoskeletal symptoms	47/68 (69.1%)	79/82 (96.3%)	11.77	20.499	<0.001	0.37
Lower-back symptoms	26/68 (38.2%)	63/82 (76.8%)	5.36	22.947	<0.001	0.391
Neck symptoms	12/68 (17.6%)	56/82 (68.3%)	10.05	38.475	<0.001	0.506
Shoulder symptoms	11/68 (16.2%)	34/82 (41.5%)	3.67	11.319	<0.001	0.275
Hypertension-range blood pressure	1/68 (1.5%)	20/82 (24.4%)	21.61	16.219	<0.001	0.329
Prediabetes	3/68 (4.4%)	8/82 (9.8%)	2.34	1.562	0.211	0.102

TABLE 3: Categorical outcomes according to years of night-shift work experience

Values are presented as number/total (percentage). Associations between categories of years of night-shift work experience and binary outcomes were assessed using Pearson's chi-square test. χ^2 , Pearson chi-square statistic; df, degrees of freedom; Cramer's V, effect size for the 2×2 association; OR, crude odds ratio. ORs represent the crude odds of each outcome among participants with >5 years of night-shift work experience compared with those with ≤5 years. CBI, Copenhagen Burnout Inventory. A two-sided p-value <0.05 was considered statistically significant.

Multivariable logistic regression

In multivariable logistic regression models treating years of night-shift work experience as a continuous exposure and adjusting for age, sex, and BMI, each additional year of night-shift work was associated with higher odds of poor sleep quality (aOR: 1.433, 95% CI: 1.118-1.835; Wald χ^2 =8.101, df=1, p=0.004), excessive daytime sleepiness (aOR: 1.205, 95% CI: 1.001-1.450; Wald χ^2 =3.891, df=1, p=0.049), CBI ≥50 (aOR: 1.810, 95% CI: 1.350-2.428; Wald χ^2 =15.701, df=1, p<0.001), overall musculoskeletal symptoms (aOR: 1.372, 95% CI: 1.003-1.878; Wald χ^2 =3.907, df=1, p=0.048), lower-back symptoms (aOR: 1.296, 95% CI: 1.051-1.598; Wald χ^2 =5.884, df=1, p=0.015), and neck symptoms (aOR: 1.272, 95% CI: 1.043-1.552; Wald χ^2 =5.631, df=1, p=0.018). The association with shoulder symptoms did not reach statistical significance (aOR: 1.220, 95% CI: 0.999-1.491; Wald χ^2 =3.789, df=1, p=0.051). Each additional year of night-shift exposure was also associated with higher odds of hypertension-range blood pressure (aOR: 1.387, 95% CI: 1.052-1.829; Wald χ^2 =5.376, df=1, p=0.021). No significant association was observed with prediabetes (aOR: 0.921, 95% CI: 0.672-1.262; Wald χ^2 =0.262, df=1, p=0.609) (Figure 3, Table 4).

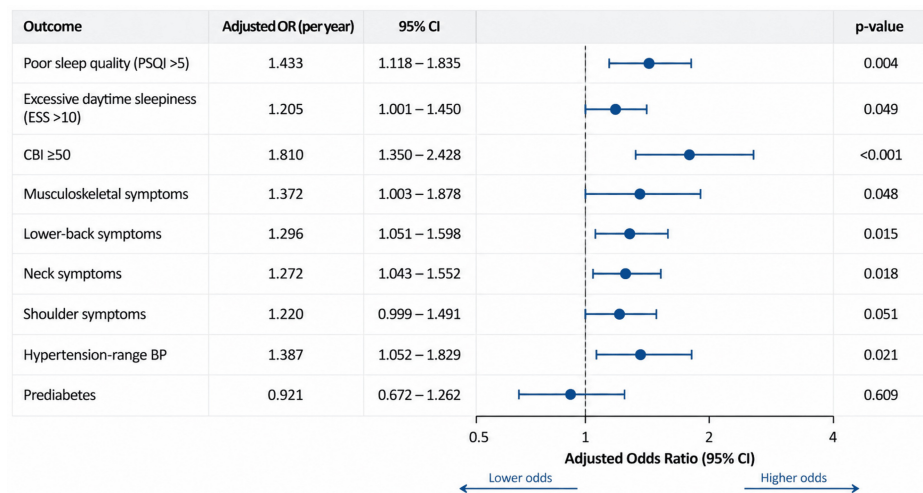


FIGURE 3: Adjusted odds ratios for occupational health outcomes per additional year of night-shift work experience

Note: Points represent adjusted odds ratios (ORs), and horizontal lines represent 95% confidence intervals (CIs). Models were adjusted for age, sex, and BMI. PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CBI, Copenhagen Burnout Inventory; BMI, body mass index.

Outcome	Adjusted OR per additional year	95% CI	Wald χ^2 (df=1)	p-value
Poor sleep quality	1.433	1.118-1.835	8.101	0.004
Excessive daytime sleepiness	1.205	1.001-1.450	3.891	0.049
CBI ≥50	1.810	1.350-2.428	15.701	<0.001
Musculoskeletal symptoms	1.372	1.003-1.878	3.907	0.048
Lower-back symptoms	1.296	1.051-1.598	5.884	0.015
Neck symptoms	1.272	1.043-1.552	5.631	0.018
Shoulder symptoms	1.220	0.999-1.491	3.789	0.051
Hypertension-range blood pressure	1.387	1.052-1.829	5.376	0.021
Prediabetes	0.921	0.672-1.262	0.262	0.609

TABLE 4: Primary multivariable logistic regression: years of night-shift work experience as a continuous exposure

Models were adjusted for age, sex, and BMI. Adjusted OR represents the change in odds of the outcome associated with each additional year of night-shift work experience. CI, confidence interval; OR, odds ratio; BMI, body mass index; CBI, Copenhagen Burnout Inventory; Wald χ^2 , Wald chi-square statistic for the regression coefficient; df, degrees of freedom.

Secondary categorical analysis

When years of night-shift work experience were categorized as ≤5 versus >5 years and adjusted for age, sex, and BMI, participants with >5 years of night-shift experience had higher odds of poor sleep quality (adjusted OR: 5.113, 95% CI: 1.596-16.385; Wald χ^2 =7.544, df=1, p=0.006), excessive daytime sleepiness (adjusted OR: 3.442, 95% CI: 1.217-9.737; Wald χ^2 =5.429, df=1, p=0.020), and CBI ≥50 (adjusted OR: 6.638, 95% CI: 1.914-23.025; Wald χ^2 =8.898, df=1, p=0.003) (Table 5).

Outcome	Adjusted OR	95% CI	Wald χ^2 (df=1)	p-value
Poor sleep quality	5.113	1.596-16.385	7.544	0.006
Excessive daytime sleepiness	3.442	1.217-9.737	5.429	0.020
CBI ≥ 50	6.638	1.914-23.025	8.898	0.003
Musculoskeletal symptoms	3.323	0.657-16.791	2.110	0.146
Lower-back symptoms	1.776	0.638-4.947	1.208	0.271
Neck symptoms	4.731	1.644-13.615	8.305	0.004
Shoulder symptoms	1.328	0.437-4.035	0.250	0.617
Hypertension-range blood pressure	10.752	1.113-103.855	4.213	0.04
Prediabetes	1.642	0.259-10.397	0.277	0.599

TABLE 5: Secondary multivariable logistic regression: >5 versus ≤ 5 years of night-shift work

Models were adjusted for age, sex, and BMI. Adjusted OR represents the odds of each outcome among participants with >5 years of night-shift experience compared with those with ≤ 5 years. CI, confidence interval; OR, odds ratio; BMI, body mass index; CBI, Copenhagen Burnout Inventory; Wald χ^2 , Wald chi-square statistic for the regression coefficient; df, degrees of freedom.

The categorical association with overall musculoskeletal symptoms was not statistically significant (adjusted OR: 3.323, 95% CI: 0.657-16.791; Wald $\chi^2=2.110$, df=1, p=0.146), nor was the association with lower-back symptoms (adjusted OR: 1.776, 95% CI: 0.638-4.947; Wald $\chi^2=1.208$, df=1, p=0.271). The association with neck symptoms remained statistically significant (adjusted OR: 4.731, 95% CI: 1.644-13.615; Wald $\chi^2=8.305$, df=1, p=0.004), whereas shoulder symptoms were not significantly associated with categories of years of night-shift work experience (adjusted OR: 1.328, 95% CI: 0.437-4.035; Wald $\chi^2=0.250$, df=1, p=0.617). Hypertension-range blood pressure remained significantly associated with more than five years of night-shift work experience (adjusted OR: 10.752, 95% CI: 1.113-103.855; Wald $\chi^2=4.213$, df=1, p=0.040), whereas prediabetes was not significantly associated with categories of years of night-shift work experience (adjusted OR: 1.642, 95% CI: 0.259-10.397; Wald $\chi^2=0.277$, df=1, p=0.599).

Linear regression and correlation analysis

In adjusted linear regression models, each additional year of night-shift work was associated with an increase in PSQI score ($\beta=0.409$, 95% CI: 0.247-0.572; t=4.974, df=146, p<0.001; $R^2=0.580$), ESS score ($\beta=0.319$, 95% CI: 0.059-0.578; t=2.429, df=146, p=0.017; $R^2=0.189$), and CBI score ($\beta=3.787$, 95% CI: 2.726-4.848; t=7.054, df=146, p<0.001; $R^2=0.646$), after adjustment for age, sex, and BMI (Table 6).

Outcome	β per additional year	95% CI	t (df=146)	p-value	R^2
PSQI score	0.409	0.247-0.572	4.974	<0.001	0.58
ESS score	0.319	0.059-0.578	2.429	0.017	0.189
CBI score	3.787	2.726-4.848	7.054	<0.001	0.646

TABLE 6: Adjusted linear regression of years of night-shift work experience with continuous PSQI, ESS, and CBI scores

Models were adjusted for age, sex, and BMI. β represents the change in the outcome score associated with each additional year of night-shift work experience. t, t-statistic for the regression coefficient; df, residual degrees of freedom; R^2 , coefficient of determination; PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CBI, Copenhagen Burnout Inventory; BMI, body mass index.

Spearman correlation analysis demonstrated a strong positive correlation between years of night-shift work experience and PSQI score ($\rho=0.744$, p<0.001) and between years of night-shift work experience and CBI score ($\rho=0.807$, p<0.001). A moderate positive correlation was observed between years of night-shift work experience and ESS score ($\rho=0.433$, p<0.001). PSQI score was positively correlated with CBI score ($\rho=0.613$, p<0.001) and ESS score ($\rho=0.486$, p<0.001). CBI score also showed a positive correlation with ESS score ($\rho=0.382$, p<0.001) (Table 7, Figure 4).

Table with 3 columns: Variable pair, Spearman ρ, and p-value. Rows include comparisons between years of night-shift work experience and PSQI, ESS, CBI, and pairwise comparisons between PSQI, ESS, and CBI.

TABLE 7: Spearman correlation analysis of principal continuous measures
Note: ρ, Spearman rank correlation coefficient; PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; CBI, Copenhagen Burnout Inventory. A two-sided p-value <0.05 was considered statistically significant.

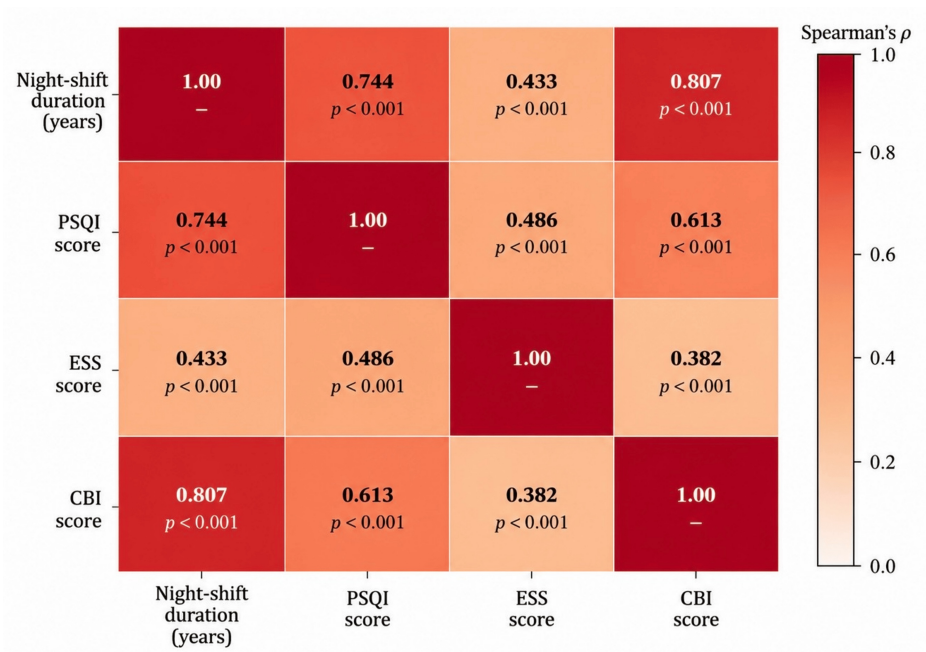


FIGURE 4: Spearman correlation heatmap of principal study variables

The heatmap shows pairwise Spearman correlation coefficients (ρ) and corresponding p-values between years of night-shift work experience, Pittsburgh Sleep Quality Index (PSQI) score, Epworth Sleepiness Scale (ESS) score, and Copenhagen Burnout Inventory (CBI) score. All off-diagonal pairwise correlations were statistically significant (p < 0.001). Higher PSQI, ESS, and CBI scores indicate poorer sleep quality, greater daytime sleepiness, and greater burnout-related symptoms, respectively.

Age, total work experience, and years of night-shift work experience showed strong positive correlations. The correlation coefficient between age and total work experience was 0.95, between total work experience and years of night-shift work experience was 0.95, and between age and years of night-shift work experience was 0.89. Variance inflation factors were approximately 5.36 for age and 5.03 for years of night-shift work experience. Total work experience was therefore excluded from the primary multivariable models to reduce multicollinearity and improve model stability.

Discussion

Principal findings

This study examined the occupational health burden associated with night-shift work among polysomnography technologists and explored the associations between years of night-shift work experience and multiple domains of health. The findings indicate that sleep disturbance, daytime sleepiness, burnout-related symptoms, and musculoskeletal symptoms are important occupational health considerations in this

population. The findings suggest that years of night-shift work experience were associated with several aspects of occupational well-being, although the strength and statistical significance of these associations varied across outcomes. However, these findings should be interpreted as associations rather than evidence of a causal relationship.

These findings are relevant to polysomnography technologists because their professional responsibilities involve overnight patient monitoring and sustained technical attention. Unlike healthcare professionals whose night duties may form one component of broader clinical responsibilities, polysomnography technologists perform overnight diagnostic monitoring as a central part of their role. Their work may involve monitoring physiological signals, maintaining recording quality, identifying technical problems, and responding to patient-related issues during sleep studies. These responsibilities may place specific demands on sustained attention and recovery after overnight duties. Nevertheless, the frequency and intensity of overnight duties vary across institutions, and years of night-shift work experience alone may not fully represent an individual's overall exposure to night work.

Sleep quality and daytime sleepiness

Poor sleep quality and excessive daytime sleepiness were important occupational health concerns among the participating polysomnography technologists. More years of night-shift work experience were associated with poorer sleep quality and greater daytime sleepiness, consistent with evidence linking night work and circadian disruption to impaired sleep quality and altered sleep duration [1,2]. Polysomnography technologists must maintain alertness during overnight monitoring, making sleep-related difficulties particularly relevant to their occupational well-being. Repeated transitions between nighttime duties and daytime recovery may also affect sleep timing and restfulness. However, individual sleep habits and other unmeasured factors may contribute to the observed associations. Given the cross-sectional design, these findings do not establish that longer night-shift work experience causes sleep disturbance or daytime sleepiness.

Burnout-related symptoms

Burnout-related symptoms were an important occupational health concern among the participating polysomnography technologists. More years of night-shift work experience were associated with higher CBI scores, and this association remained evident after adjustment for age, sex, and BMI. The demands of overnight monitoring, including sustained attention, equipment management, and responding to patient-related requirements, may contribute to occupational strain. Sleep disturbance and burnout-related symptoms may also coexist, although the cross-sectional design does not establish the direction of this relationship. Previous systematic-review evidence has reported an association between burnout and sleep problems among nurses [4]. The present findings extend this area of investigation to polysomnography technologists, whose work routinely involves overnight monitoring. Importantly, the CBI measures burnout-related symptoms rather than diagnosing a psychiatric disorder. The categorical thresholds used in this study were operational classifications and should not be interpreted as universally established clinical thresholds for burnout.

Musculoskeletal symptoms

Musculoskeletal symptoms were a prominent occupational health concern among the participating polysomnography technologists, particularly involving the lower back and neck. Previous research has identified musculoskeletal disorders as an important occupational health problem among healthcare workers, with physical demands, prolonged static postures, repetitive activities, fatigue, and ergonomic factors potentially contributing to symptoms [5,6]. For polysomnography technologists, overnight duties may involve prolonged sitting or standing, repeated sensor and equipment adjustments, and patient assistance, potentially contributing to sustained or constrained postures. The association with night-shift work experience varied by anatomical region, and shoulder symptoms did not reach statistical significance in the adjusted analysis.

These findings should be interpreted cautiously because the study was cross-sectional and musculoskeletal symptoms were participant-reported. The observed associations do not establish that night-shift work causes musculoskeletal symptoms. Prospective studies incorporating objective ergonomic assessments and detailed measures of physical workload are needed to clarify these relationships.

Cardiometabolic outcomes

Longer years of night-shift work experience were associated with hypertension-range blood pressure. This finding is consistent with evidence from systematic reviews and meta-analyses reporting an association between night-shift or rotational shift work and hypertension [3]. Circadian disruption, sleep disturbance, altered autonomic regulation, and occupational stress may contribute to this relationship, although these mechanisms were not directly evaluated in the present study.

No statistically significant association was observed between years of night-shift work experience and prediabetes. The relatively small number of participants meeting the study criteria for prediabetes may have

limited the precision and statistical power of this analysis. Blood pressure was participant-measured, and glycemic information was obtained from recent laboratory reports rather than through a standardized study-specific clinical assessment. These findings should therefore be interpreted as indicators of potential cardiometabolic risk rather than definitive clinical diagnoses. The cross-sectional design also prevents conclusions about the temporal or causal relationship between night-shift work experience and these outcomes.

Associations with years of night-shift work experience and interrelationships between outcomes

Years of night-shift work experience were analyzed as a continuous exposure in the primary analyses, with a secondary comparison of participants with ≤ 5 years and > 5 years of experience. Longer night-shift work experience was associated with higher PSQI, ESS, and CBI scores after adjustment for age, sex, and BMI. However, years of experience alone do not capture the frequency or intensity of overnight duties, consecutive night shifts, total night-work hours, or recovery intervals.

The adjusted associations with excessive daytime sleepiness and overall musculoskeletal symptoms were borderline statistically significant ($p=0.049$ and $p=0.048$, respectively), with confidence intervals close to the null value. These findings should be interpreted cautiously because the estimates are relatively imprecise and may be sensitive to residual confounding. The association with shoulder symptoms did not reach statistical significance ($p=0.051$). These results should therefore be considered suggestive rather than conclusive.

Correlation analyses also demonstrated relationships among years of night-shift work experience, sleep quality, daytime sleepiness, and burnout-related symptoms. The positive correlations between PSQI, ESS, and CBI scores suggest that these outcomes may coexist, although the cross-sectional design cannot establish their temporal sequence or direction of influence. Overall, these findings indicate associations rather than a definitive causal dose-response relationship. Longitudinal studies incorporating detailed shift schedules, overnight work hours, and recovery intervals are needed to clarify how night-shift work experience relates to occupational health outcomes.

Multicollinearity and interpretation of occupational exposure

Age, total work experience, and years of night-shift work experience were strongly correlated in this study. Total work experience was therefore excluded from the primary multivariable models to reduce multicollinearity, while years of night-shift work experience were retained as the principal exposure. The models were adjusted for age, sex, and BMI. Despite adjustment, the strong correlation between age and years of night-shift work experience ($r=0.89$) raises the possibility of residual confounding by age. Consequently, the independent associations of age and night-shift work experience with the assessed health outcomes may be difficult to distinguish, and the adjusted findings should be interpreted cautiously.

Practical implications

The findings highlight the potential value of occupational health strategies addressing fatigue, recovery, and ergonomic conditions in sleep laboratories. Scheduling practices that allow adequate recovery after overnight duties may support occupational well-being. Ergonomic measures, including adjustable seating and monitor height, appropriate workstation positioning, and opportunities to change posture and take brief movement breaks, may help reduce prolonged musculoskeletal loading without compromising patient monitoring.

Periodic occupational health assessments could include sleep quality, daytime sleepiness, burnout-related symptoms, blood pressure, and relevant metabolic indicators. Although interventions addressing night work have been examined among healthcare professionals, available evidence remains heterogeneous and should be adapted to the specific workflow of sleep laboratories [11]. These recommendations should be considered potential strategies rather than interventions proven by the present study. Prospective research is needed to evaluate whether scheduling, recovery, and ergonomic interventions improve occupational health outcomes among polysomnography technologists.

Strengths and limitations

This study has several strengths. It focused on a relatively understudied occupational group and evaluated multiple domains of occupational health within the same population. The use of established assessment instruments, including the PSQI, ESS, CBI, and Nordic musculoskeletal assessment, enabled standardized evaluation of sleep, daytime sleepiness, burnout-related symptoms, and musculoskeletal symptoms. Years of night-shift work experience were examined both as a continuous exposure and as a categorical variable, allowing assessment of potential exposure-related patterns. The study also considered sleep-related, psychological, musculoskeletal, and selected cardiometabolic outcomes within the same occupational population.

Several limitations should be considered. First, the cross-sectional design prevents determination of temporal or causal relationships between years of night-shift work experience and the assessed health outcomes. Therefore, the observed associations cannot establish whether longer night-shift work experience preceded the reported health problems. Reverse causation and residual confounding cannot be excluded. Second, electronic recruitment through professional groups may have introduced selection bias and may limit the representativeness of the sample.

Third, although the study focused on polysomnography technologists in India, the analyzed participants were recruited from private-sector settings in South India. The exact number of participating hospitals and sleep centers and the state-wise distribution of participants were not systematically documented. Consequently, the representativeness of the sample across institutions, states, and healthcare systems could not be fully assessed, and the findings may not be directly generalizable to polysomnography technologists working in other regions or settings in India.

Fourth, height, weight, and blood pressure were measured or reported by participants rather than obtained through standardized assessments conducted by trained research personnel. Sleep quality, daytime sleepiness, and musculoskeletal symptoms were also assessed using participant-reported information, which may have introduced recall, reporting, and measurement bias. Glycemic variables were obtained from recent laboratory reports rather than through a uniform study-specific laboratory protocol. These limitations may have affected the precision of the measurements, including BMI estimation, and should be considered when interpreting the adjusted associations.

Fifth, potentially relevant confounding factors, including habitual sleep duration, caffeine and stimulant use, chronotype, family responsibilities, psychosocial stressors, physical activity, and detailed shift-scheduling characteristics, were not comprehensively assessed. In particular, the number of overnight duties per week, consecutive night shifts, total night-work hours, and recovery intervals between duties were not comprehensively quantified. These omissions may have contributed to residual confounding and limit the extent to which the observed associations can be attributed specifically to years of night-shift work experience.

Sixth, the strong correlation between age and years of night-shift work experience ($r=0.89$), together with the correlation between total work experience and years of night-shift work experience, may have limited the ability to distinguish their independent associations with the assessed health outcomes. Total work experience was excluded from the primary multivariable models to reduce multicollinearity; however, age and years of night-shift work experience remained strongly correlated. Therefore, residual confounding by age and related occupational factors cannot be excluded, even after adjustment for age, sex, and BMI.

Seventh, the number of participants meeting the study criteria for prediabetes was relatively small, limiting the statistical power and precision of the corresponding analysis. Finally, CBI was primarily analyzed as a continuous measure, while CBI ≥ 50 was used as a secondary binary outcome. The CBI categories used in this study were operational classifications and should not be interpreted as universal diagnostic thresholds for burnout.

Conclusions

Polysomnography technologists participating in this study reported important occupational health concerns, particularly poor sleep quality, excessive daytime sleepiness, burnout-related symptoms, and musculoskeletal symptoms. More years of night-shift work experience were associated with higher PSQI, ESS, and CBI scores and with increased odds of several occupational health outcomes after adjustment for age, sex, and BMI. These findings should be interpreted cautiously because of the cross-sectional design, potential residual confounding, and incomplete assessment of night-shift intensity and scheduling characteristics.

The findings highlight the potential importance of occupational strategies addressing fatigue management, adequate recovery following overnight duties, ergonomic working conditions, and periodic health assessment. Prospective multicenter studies involving polysomnography technologists from different regions of India are warranted to clarify the long-term health implications of night-shift work experience and evaluate the effectiveness of workplace interventions.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Eldhos Jacob

Acquisition, analysis, or interpretation of data: Eldhos Jacob, Carishma S, Srishankar Bairy, Ajith PA,

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Drafting of the manuscript: Eldhos Jacob, Carishma S, Srishankar Bairy

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Supervision: Eldhos Jacob

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Father Muller Institutional Ethics Committee, Father Muller Medical College Hospital, Mangaluru, India issued approval FMIEC/CCM/918/2025, date: 19-11-2025. Electronic informed consent for participation in the study and open-access publication was obtained from all participants. Participation was voluntary, and participants could decline to participate at any time. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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