

Neurophysiological and Sociocultural Burden of Night Shift Work: A Multidimensional Analysis

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Abstract

Background: Gender differences in sleep disturbances among night shift workers, especially mothers, are influenced by biological and cultural factors, with insomnia and cardiovascular strain heightened during night shifts.

Objectives: The main goals are to evaluate gender-specific differences in sleep disruption and blood pressure, assess correlations between demographic variables (age, education, parenthood) and circadian preferences, and identify the mechanisms linking shift work to autonomic dysfunction.

Methods: A cross-sectional analysis was conducted in 2023 using standardized questionnaires (DRS-15, CTI) and calibrated blood pressure measurements. Non-parametric Spearman correlations were performed using SPSS version 27 for non-normally distributed data, as indicated by the Kolmogorov-Smirnov test ($P < 0.05$).

Results: Women exhibited a stronger preference for routine stability ($r = -0.102$, $P = 0.037$), while higher education was associated with greater openness to change ($r = -0.095$, $P = 0.043$). In terms of cardiovascular effects, blood pressure had weak but significant correlations with wake time ($r = 0.114$, $P = 0.014$), indicating a circadian-autonomic relationship. Parenthood reduced sleep efficiency by 13%, while marital status and education had minimal effects ($R^2 < 1.3\%$).

Conclusion: This study highlights the importance of multidimensional interventions addressing the physiological (blood pressure management) and sociocultural (childcare support) aspects of shift-work-related health problems. Future research should combine actigraphy with metabolomic profiling to further understand chronic disease pathways.

Keywords: Shift Work Schedule, Circadian Rhythms, Essential Hypertension, Insomnia

1. Background

Gender differences in circadian dysregulation among night shift workers are significant, with biological, sociocultural, and policy factors playing a role. Tailored interventions and structural reforms are crucial for improving health outcomes.¹

Mothers working night shifts experience shorter sleep duration and poorer sleep efficiency, which is also reflected in their children. In contrast, families in the day-shift group have more synchronized sleep schedules.²

Among night shift workers, sleep disruption often persists due to naps replacing continuous restorative sleep, leading to circadian misalignment. Recommended countermeasures include exposure to bright light, melatonin supplementation, and improved shift scheduling. While primary sleep disorders are not more prevalent among night workers, nearly 43% report insomnia, primarily attributed to poor sleep practices rather than intrinsic sleep issues.³

A study by Boersma et al. (2023) examined the impact

of shift work on sleep health, particularly focusing on night workers, using data from 37,662 individuals in Belgium. Their findings revealed that 50% of night workers reported short sleep duration (≤ 6 hours), compared to 26% of day workers. Night workers also faced a higher burden of sleep disorders, such as insomnia and circadian rhythm disturbances, with lower educational attainment linked to more severe sleep problems.⁴

Research on ambulatory blood pressure (ABP) across work and home settings, stratified by gender and family composition, yielded interesting results. Men with children had significantly higher diastolic ABP at work than at home, suggesting that occupational stress may be more taxing for fathers. In contrast, women without children showed elevated ABP at work and on days off compared to at home, indicating a stronger cardiovascular response to occupational strain.⁵

A systematic review and meta-analysis of 45 studies involving 117,252 workers explored the relationship between shift work and blood pressure. Permanent night

shifts were associated with significant increases in both systolic and diastolic blood pressure.⁶

Silva-Costa et al. (2021) found that working more than four-night shifts per fortnight was linked to elevated blood pressure, with a higher risk of hypertension.⁷ Su et al. (2009) demonstrated that 12-hour night shifts placed strain on the cardiovascular system, leading to increased blood pressure and reduced heart rate variability compared to day-shifts.⁸

Merijanti et al. (2008) observed higher systolic blood pressure among female shift workers, along with a higher prevalence of overweight status, potentially due to circadian disruption and insufficient sleep.⁹ Insomnia in women may be exacerbated by sociobiological pressures, such as unpaid caregiving responsibilities, highlighting the need for policy reforms to address domestic labor strain.^{10,11}

2. Objectives

This study aims to explore the intricate relationship between nocturnal work schedules and their impact on sleep patterns, heart health, and professional stress, with a focus on sociocultural factors and gender-related susceptibilities. The goal is to assess how night shift employment affects the cardiovascular well-being and sleep quality of male and female staff at the Behbahan Faculty of Medical Sciences.

3. Methods

3.1. Research Design and Setting

This cross-sectional study was conducted within three government hospitals affiliated with the Behbahan Faculty of Medical Sciences: Shahidzadeh Behbahan Hospital, Farideh Behbahani Hospital, and Vali Asr Hospital during 2023. The study used convenience sampling. The sampling frame included employees from various departments, such as clinical, paraclinical, security, and support services. A total of 355 employees participated in the study, with 200 from Shahidzadeh Behbahan Hospital, 110 from Farideh Behbahani Hospital, and 45 from Vali Asr Hospital.

3.2. Data Collection Instruments

The study utilized a comprehensive questionnaire consisting of four standardized tools: the Dispositional Resilience Scale (DRS-15), the Day-Orientation Type Scale, the Modified Circadian Pattern (CTI) questionnaire, and a survey assessing shift work and associated problems. The questionnaire responses underwent a rigorous multi-stage filtering process, including automated preprocessing, expert review with blinded double evaluation, and consensus adjudication to ensure data accuracy and integrity.¹²

3.3. Blood Pressure Measurement Protocol

Systolic blood pressure (SBP) measurements were taken

using calibrated sphygmomanometers, following ISO standards and American College of Cardiology/American Heart Association guidelines. The measurement environment was optimized for quietness and temperature control, and participants were positioned correctly. After a 5-minute rest period, participants were instructed to avoid consuming caffeine or nicotine and exercising prior to the measurement. SBP was recorded with an accuracy of 2 mmHg, and the arm and position were documented.¹³

3.4. Statistical Analysis

The analysis began with descriptive statistics, followed by assessing data distribution using the Kolmogorov-Smirnov test. Relationships among variables were examined using non-parametric Spearman and Kendall correlation analyses. All statistical analyses were performed with IBM SPSS Statistics 27.0.1.0 (USA), and statistical significance was set at $P < 0.05$, with $P < 0.01$ considered highly significant.¹⁴

4. Results

4.1. Data Distribution Results

The application of the one-sample Kolmogorov-Smirnov test revealed that the dataset failed to satisfy the criteria for a normal distribution, as evidenced by significant outcomes ($P < 0.05$) across all measured variables. Consequently, the study employed non-parametric analytical techniques, specifically utilizing the Spearman rank correlation coefficient, to evaluate the associations between the variables and present the findings.

4.2. Correlation Coefficients between Demographic Variables (Gender, Age, Marital Status, Number of Children, Education Level, and Blood Pressure) and Likert-Scale Items Assessing Attitudes Toward Work, Life Meaning, and Agency

The table presents Spearman correlation coefficients between demographic variables (gender, age, marital status, number of children, education level, and blood pressure) and 15 Likert-scale items assessing attitudes toward work, life meaning, and agency. Notably, gender exhibits a small negative correlation with resistance to changing regular activities ($r = -0.102$, $P = 0.037$), suggesting that women may prefer routine stability more than men. Similarly, the number of children shows a negative correlation with this preference ($r = -0.113$, $P = 0.014$), indicating that parents with more children favor stable routines. Conversely, higher education levels correlate negatively with the desire for a static life plan ($r = -0.095$, $P = 0.043$), implying greater openness to change among highly educated individuals. All observed effects are small ($|r| < 0.12$), with the number of children explaining only 1.3% of the variance ($r^2 = 0.0128$). Blood pressure showed no significant correlations. While the sample size ($N = 349$) is sufficient for detecting

medium effects at $\alpha = 0.05$, the lack of Bonferroni correction and the use of pairwise deletion for missing values warrant cautious interpretation. Given that correlation does not imply causation, these findings should be interpreted with caution, as psychological or situational factors may exert a stronger influence on attitudes than the assessed

demographics. The data indicate that demographic variables have minimal predictive power regarding attitudes toward work, life meaning, and agency. Consequently, this limited influence underscores the necessity of exploring other contributing factors to fully understand the determinants of these attitudes (Table 1, Figure 1).

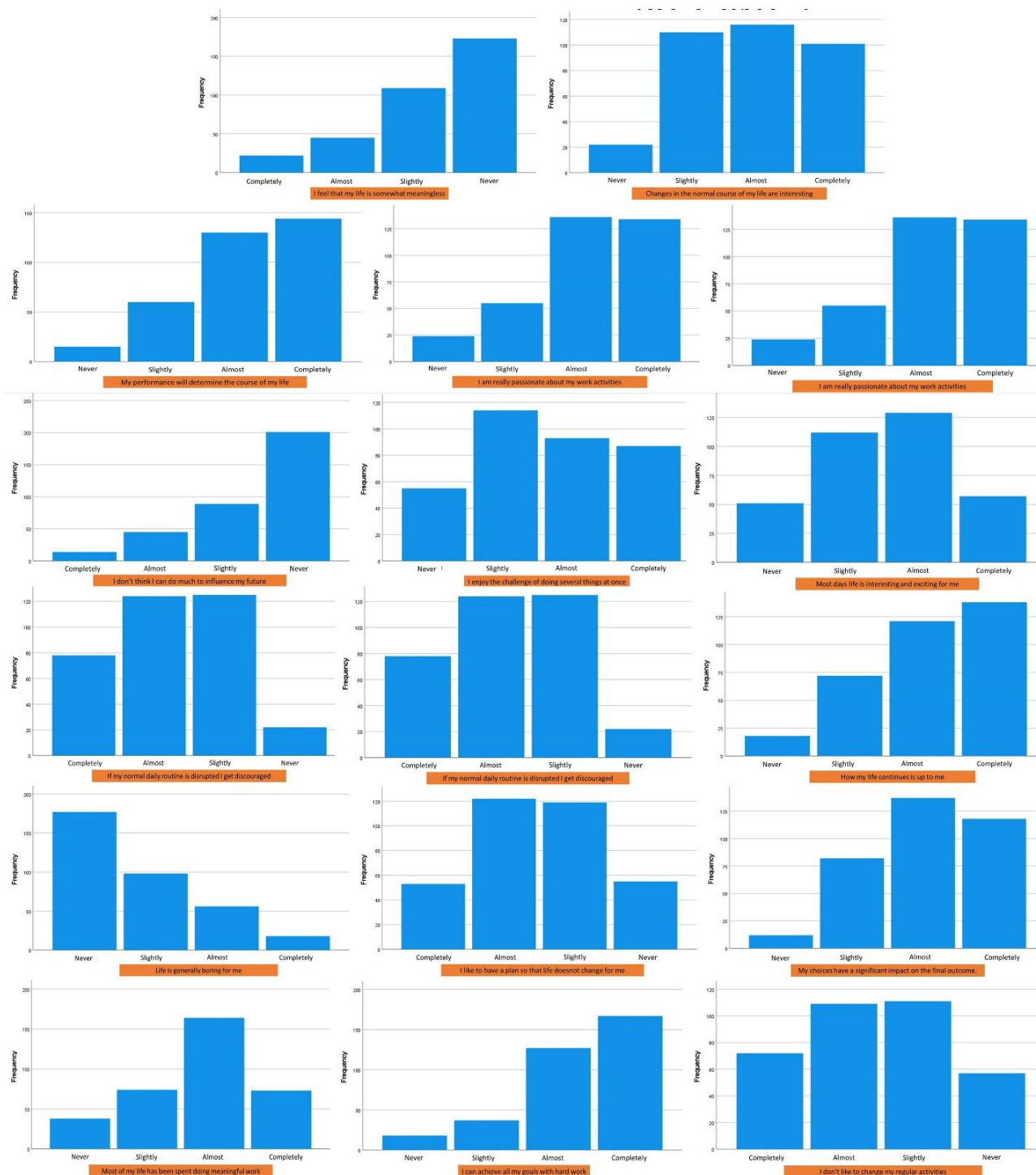


Figure 1. Results of Answers to Likert-Scale Items Assessing Attitudes Toward Work, Life Meaning, and Agency.

4.3. Correlation Between Demographic Factors and Sleep-Related Variables

The analysis reveals that demographic factors have a limited impact on sleep-related variables, suggesting that

biological determinants play a more significant role in shaping sleep-wake preferences. Notably, a correlation between blood pressure and wake time ($r = 0.114$, $P = 0.014$) and negative feelings regarding early awakenings

Table 1. Correlational Results between Demographic Variables and Likert-Scale Items Assessing Attitudes Toward Work, Life Meaning, and Agency

Number of children	Marital status			Age			Gender			Variables	
	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)		
0.012	349	0.900	0.006	0.007	349	0.869	0.007	349	0.230	0.060	Most of my life has been spent doing meaningful work
0.057	349	0.224	0.061	0.055	349	0.191	0.055	349	0.938	0.004	I can achieve all my goals with hard work
-.113*	349	0.153	-0.070	-0.077	349	0.061	-0.077	349	0.037	-.102*	I do not like to change my regular activities
-0.045	349	0.662	0.022	-0.038	349	0.372	-0.038	349	0.768	-0.015	I feel that my life is somewhat meaningless
-0.029	349	0.182	-0.066	0.002	349	0.954	0.002	349	0.092	0.084	Changes in the normal course of my life are interesting
0.073	349	0.308	0.051	0.075	349	0.074	0.075	349	0.360	0.046	My performance will determine the course of my life
-0.022	349	0.879	0.008	0.013	349	0.754	0.013	349	0.323	0.049	I am really passionate about my work activities
-0.027	349	0.443	-0.039	-0.007	349	0.864	-0.007	349	0.279	0.055	I do not think I can do much to influence my future
-0.054	349	0.329	-0.048	0.023	349	0.567	0.023	349	0.119	0.077	I enjoy the challenge of doing several things at once
-0.026	349	0.375	-0.044	-0.021	349	0.613	-0.021	349	0.233	0.059	Most days life is interesting and exciting for me
0.027	349	0.444	0.038	0.013	349	0.754	0.013	349	0.843	-0.010	If my normal daily routine is disrupted, I get discouraged
-0.007	349	0.535	-0.031	-0.019	349	0.644	-0.019	349	0.727	0.017	How my life continues is up to me
0.013	349	0.405	-0.042	0.023	349	0.590	0.023	349	0.151	-0.072	Life is generally boring for me
0.015	349	0.815	0.011	-0.007	349	0.859	-0.007	349	0.143	0.072	I like to have a plan so that life does not change for me
0.007	349	0.553	0.030	0.005	349	0.905	0.005	349	0.576	0.028	My choices have a significant impact on the final outcome.

Blood pressure			Level of education		
N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient
349	0.597	-0.025	349	0.680	-0.019
349	0.721	-0.017	349	0.254	0.055
349	0.793	-0.012	349	0.070	0.084
349	0.150	-0.069	349	0.374	0.043
349	0.818	-0.011	349	0.382	-0.041
349	0.439	-0.037	349	0.264	-0.053
349	0.674	0.020	349	0.522	-0.030
349	0.135	-0.072	349	0.855	0.009
349	0.304	-0.048	349	0.716	-0.017
349	0.106	0.075	349	0.595	0.025
349	0.804	-0.012	349	0.350	-0.044
349	0.877	-0.007	349	0.750	0.015
349	0.819	0.011	349	0.571	-0.027
349	0.821	-0.011	349	0.043	-.095*
349	0.742	-0.016	349	0.301	0.049
349			349		

($r = 0.099$, $P = 0.033$) indicate a connection between circadian rhythms and autonomic nervous system activity. Furthermore, age is weakly correlated with recovery time ($r = 0.082$, $P = 0.047$), and EEG data show increased sleep inertia in individuals over 60, which has been attributed to reduced slow-wave sleep amplitude and slower adenosine clearance. While certain demographic variables, such as education, show weak associations with sleep behavior (e.g., education and bedtime: $r = 0.080$, $P = 0.101$), the minimal variances in findings (all $R^2 < 1.3\%$) signify low clinical relevance for these variables in sleep interventions. Overall, the results advocate that sleep timing is primarily influenced by chronobiological factors, with significant correlations between age, blood pressure, and sleep preferences, and they reinforce the dominance of biological traits in shaping sleep preferences (Table 2, Figure 2).

4.4. Correlation Study Results Between Physiological and Demographic Factors with a Series of Questions Regarding Sleep and Wakefulness Patterns

The results indicate that, for most variables, there is no statistically significant relationship between demographic characteristics and sleep/wake habits, as evidenced by Sig. (2-tailed) values greater than 0.05. However, two notable exceptions emerged: a significant negative correlation between age and the tendency to need compensatory

sleep after late bedtimes ($r = -0.108$, $P = 0.007$), suggesting that older individuals tend to perceive a decreased need for extra sleep following late nights; and a significant positive correlation between blood pressure and the ability to stay awake late without feeling tired under pressure ($r = 0.110$, $P = 0.015$), indicating a slight tendency for individuals with higher blood pressure to report greater alertness in the evening. These findings suggest that sleep patterns in this study group are largely independent of demographic factors, with only age and blood pressure exerting minor, statistically significant influences on specific sleep behaviors (Table 3, Figure 3).

4.5. Correlation Analysis between Several Demographic/Physiological Variables (Gender, Age, Marital Status, Number of Children, Level of Education, and Blood Pressure) and a Wide Array of Work-Related and Sleep-Related Factors Among 351 Participants

The analysis by variable reveals several significant correlations. Gender exhibits notable associations, particularly with work-life balance and shift preferences. For instance, it demonstrates strong positive correlations with spousal employment status ($r = 0.298$, $P < 0.001$) and spousal shift work ($r = 0.138$, $P = 0.007$). Moreover, gender is negatively correlated with having a second job ($r = -0.229$, $P < 0.001$) and current job experience ($r = -0.131$, $P = 0.004$). Furthermore, it is significantly linked

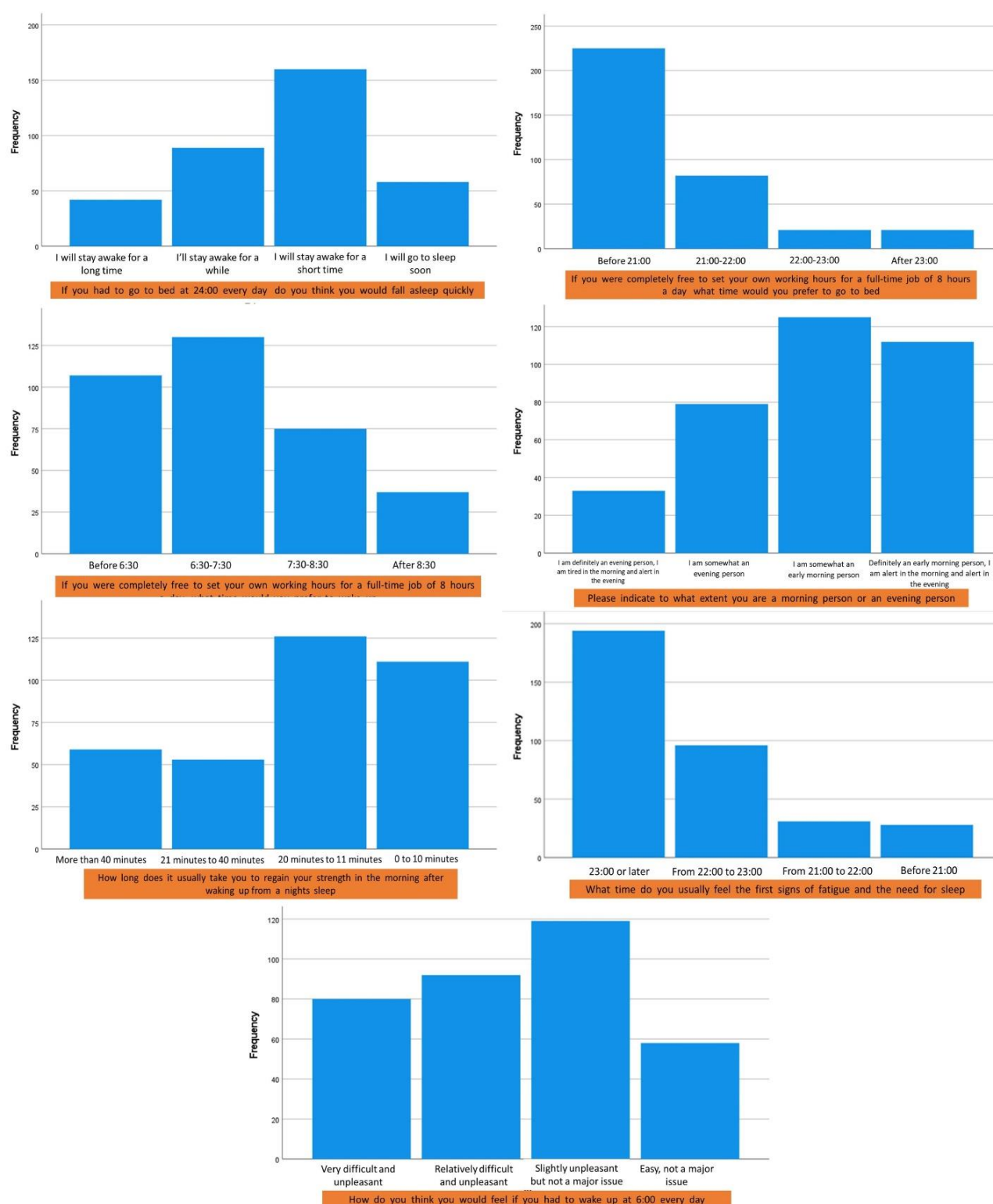


Figure 2. Results of Answers to a Series of Questions on Sleep-Related Variables Questionnaire.

to sleep difficulties ($r = 0.195$, $P < 0.001$) and a lower willingness to continue shift work ($r = -0.097$, $P = 0.047$). Age, one of the most influential variables, demonstrates a strong positive correlation with total work experience ($r = 0.739$, $P < 0.001$) and current job experience ($r = 0.598$, $P = 0.001$). Additionally, age is associated with years of experience in the shift system ($r = 0.634$, $P < 0.001$) and negatively correlated with average sleep hours during

evening ($r = -0.144$, $P < 0.001$) and night shifts ($r = -0.140$, $P < 0.001$).

The analysis also highlights significant relationships between marital status, number of children, level of education, and various aspects of work and health. For example, marital status is heavily linked to family and stability factors, such as spousal employment ($r = -0.756$, $P < 0.001$) and shift work ($r = -0.778$, $P < 0.001$).

Table 2. Correlation between Demographic Factors and Sleep-Related Variables

Level of education	Number of children				Marital status				Age				Gender				Variables
	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	
-0.014	349	0.417	0.038	349	0.291	0.848	0.052	349	0.571	0.023	349	0.451	0.037	349	0.451	0.037	If you were completely free to set your own working hours for a full-time job of 8 hours a day, what time would you prefer to wake up
0.080	349	0.470	-0.035	349	0.848	0.848	-0.010	349	0.520	-0.028	349	0.335	-0.049	349	0.335	-0.049	If you were completely free to set your own working hours for a full-time job of 8 hours a day, what time would you prefer to go to bed
-0.068	349	0.516	0.030	349	0.237	0.237	0.058	349	0.102	0.068	349	0.471	0.036	349	0.471	0.036	If you had to go to bed at 24:00 every day, do you think you would fall asleep quickly
-0.002	349	0.953	0.003	349	0.976	0.976	-0.001	349	0.397	0.035	349	0.352	0.046	349	0.352	0.046	How do you think you would feel if you had to wake up at 6:00 every day
0.072	349	0.775	0.014	349	0.967	0.967	-0.002	349	0.459	0.031	349	0.197	-0.065	349	0.197	-0.065	What time do you usually feel the first signs of fatigue and the need for sleep
0.000	349	0.282	0.050	349	0.084	0.084	0.085	349	0.047	.082*	349	0.587	0.027	349	0.587	0.027	How long does it usually take you to regain your strength in the morning after waking up from a night's sleep
0.003	349	0.970	0.002	349	0.718	0.718	0.018	349	0.401	0.035	349	0.646	0.023	349	0.646	0.023	Please indicate to what extent you are a morning person or an evening person

Blood pressure				
	N	Sig. (2-tailed)	Correlation Coefficient	N
	349	0.014	.114*	349
	349	0.728	-.017	349
	349	0.654	0.021	349
	349	0.033	.099*	349
	349	0.091	-.081	349
	349	0.130	0.071	349
	349	0.699	0.018	349
	349	0.758	0.101	349
	349	0.147	0.974	349
	349	0.134	0.993	349
	349	0.950		349



Figure 3. Results of Answers to a Series of Questions Regarding Sleep and Wakefulness Patterns.

Moreover, the number of children is positively correlated with work experience ($r = 0.529$, $P < 0.001$) and shift system experience ($r = 0.492$, $P < 0.001$), but negatively associated with sleep hours during evening ($r = -0.131$, $P = 0.003$) and night shifts ($r = -0.122$, $P = 0.005$). Furthermore, higher education levels are associated with a more positive view of the shift system's benefits ($r =$

0.125 , $P = 0.006$) and general satisfaction ($r = 0.133$, $P = 0.003$), despite having less overall work experience. Overall, the findings suggest that experience, age, marital status, and family factors are intertwined with sleep patterns, work-life balance, and satisfaction with the shift system.

The provided table elucidates a complex correlation analysis

Table 3. Correlation Coefficients between Physiological and Demographic Factors with a Series of Questions Regarding Sleep and Wakefulness Patterns

Number of children	Marital status			Age			Gender			Variables
	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	
	-0.049	350	0.430	-0.038	350	0.099	-0.067	350	0.257	Do you tend to sleep more than other people
	0.045	350	0.120	0.075	350	0.916	-0.004	350	0.695	If you have to do a certain task in the middle of the night, do you think you can do it as easily as you, do it at normal times of the day
	0.032	350	0.458	0.036	350	0.838	0.008	350	0.477	If you are woken up at unusual times is it difficult for you to wake up compared to other times
	0.022	350	0.449	0.036	350	0.572	-0.023	350	0.707	Do you enjoy working at unusual times of the night or day
	-0.030	350	0.067	-0.088	350	0.007	-.108**	350	0.981	If you go to bed very late, do you need more sleep the next morning
	0.028	350	0.167	0.066	350	0.136	0.060	350	0.276	If you have a lot of work to do can you stay up late without feeling too tired
	0.006	350	0.798	-0.012	350	0.529	-0.025	350	0.931	Do you feel sleepy for a while after waking up in the morning
	-0.037	350	0.354	-0.044	350	0.496	-0.027	350	0.953	Is working late at night as easy for you as it is early in the day
	-0.032	350	0.598	-0.025	350	0.253	-0.046	350	0.581	If you have to wake up very early in the morning, do you feel tired all day long
	-0.011	350	0.715	0.018	350	0.595	-0.022	350	0.218	Do you feel more refreshed doing some tasks at midnight than doing them during the day
	-0.057	350	0.668	-0.021	350	0.068	-0.074	350	0.943	Do you rely on an alarm clock or someone else to wake you up in the morning

Blood pressure						Level of education					
N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient
350	0.058	-0.087	350	0.411	0.038	350	0.282				
350	0.407	0.038	350	0.161	0.064	350	0.315				
350	0.476	0.032	350	0.333	0.044	350	0.480				
350	0.619	0.023	350	0.158	0.065	350	0.618				
350	0.957	0.002	350	0.537	0.028	350	0.508				
350	0.015	.110*	350	0.958	-0.002	350	0.527				
350	0.953	0.003	350	0.711	-0.017	350	0.902				
350	0.902	0.006	350	0.093	0.077	350	0.407				
350	0.266	-0.051	350	0.436	0.036	350	0.479				
350	0.606	-0.024	350	0.462	0.034	350	0.813				
350	0.873	0.007	350	0.696	0.018	350	0.209				

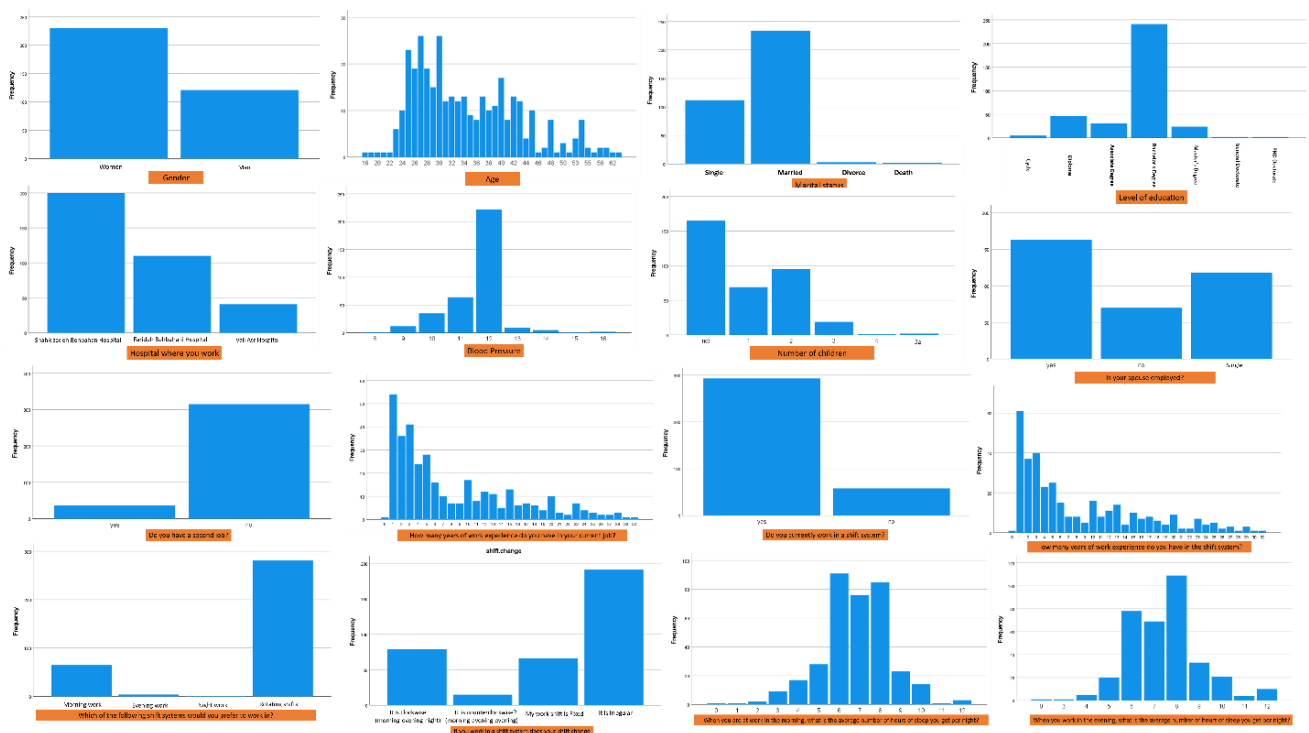


Figure 4. Results of Answers to a Series of Questions on a Wide Array of Work-Related and Sleep-Related Factors (Part A).

involving demographic and physiological variables, specifically gender, age, marital status, number of children, education level, and blood pressure, and their associations with various occupational and sleep-related factors among a sample of 351 participants. Gender demonstrated statistically significant correlations with

spousal employment status, secondary job holding, and work experience, alongside notable links to sleep disturbances and blood pressure levels. Furthermore, gender exhibited a strong negative correlation with age and a positive correlation with blood pressure within this dataset, highlighting distinct physiological and lifestyle



Figure 5. Results of Answers to a Series of Questions on a Wide Array of Work-Related and Sleep-Related Factors (Part B).

patterns associated with male and female participants.

Age emerged as a pivotal variable, showing robust positive associations with total work experience, tenure in the current position, and duration of shift work participation. Conversely, increasing age was negatively correlated with sleep duration during evening and night shifts, as well as with blood pressure in this specific cohort. Additionally, age correlated positively with education level and the number of children, suggesting that older employees in this sample tended to have higher educational attainment and larger families, while simultaneously experiencing reduced sleep continuity

during non-standard working hours.

Marital status, number of children, and education level further refined the understanding of workforce dynamics. Marital status and the number of children were strongly negatively correlated with spousal employment and positively correlated with work experience; yet both were associated with reduced sleep hours during shifts and a lower willingness to continue shift work. Higher education levels, while negatively correlated with total work experience, were positively linked to the perceived benefits of shift work and overall job satisfaction. Finally, blood pressure showed specific, albeit weaker, correlations with night

shift sleep duration, sleep difficulties, and night shift workload, underscoring the nuanced interplay between physiological health and occupational demands (Supplementary Appendix 1, Figures 4, and 5).

5. Discussion

The findings of the present study underscore the complex interplay, or lack thereof, between demographic variables and psychological, occupational, and sleep-related outcomes. Due to the non-normal distribution of the data, non-parametric analyses were employed, revealing that demographics possess minimal predictive power regarding attitudes toward work, life meaning, and agency (all $|r| < 0.12$, $R^2 < 1.3\%$). This is consistent with prior research suggesting that psychological constructs, such as personality traits and situational stressors, often outweigh demographic factors in shaping these attitudes.¹⁵ Notably, the negative correlation between education level and resistance to change ($r = -0.095$, $P = 0.043$) echoes findings that higher education fosters cognitive flexibility.¹⁶ However, the trivial effect sizes ($r^2 \approx 0.9\%$) caution against overinterpretation and reinforce the necessity of exploring latent variables, such as socioeconomic status and cultural norms, which may mediate these relationships.

Similarly, sleep-related outcomes were predominantly driven by biological factors, with demographics exerting a negligible influence ($R^2 < 1.3\%$). The correlation between blood pressure and evening alertness ($r = 0.110$, $P = 0.015$) may reflect autonomic nervous system arousal,¹⁷ while the age-related decline in compensatory sleep need ($r = -0.108$, $P = 0.007$) mirrors the reduction of slow-wave sleep in older adults.¹⁸ Nevertheless, the clinical insignificance of these associations ($R^2 \approx 1.2\%$) suggests that sleep interventions should prioritize circadian and homeostatic regulation over demographic profiling.

Furthermore, gender disparities in work-life balance ($r = 0.298$, $P < .001$ for spousal employment) align with gendered labor division theories, while the correlation between age and shift-work tolerance ($r = -0.131$, $P = 0.004$) may reflect a decline in circadian plasticity.^{15,19}

5.1. Recommendations

To address circadian disruptions in healthcare workers, hospitals should establish bright light therapy stations in break areas to counteract phase delays while implementing compulsory 20-minute nap periods to manage sleep inertia effectively.²⁰ Pharmacological measures should include employer-funded melatonin supplementation (0.5–3 mg) administered 30 minutes prior to daytime sleep, with dosage adjustments accounting for menstrual cycle variations in premenopausal staff.²¹ Shift scheduling must adopt a chronobiologically sound clockwise rotation (morning $\rightarrow$ evening $\rightarrow$ night) to mirror endogenous circadian rhythms, capped at three consecutive night shifts to minimize sleep debt accumulation. Furthermore,

gender-responsive interventions such as 24-hour on-site childcare facilities would alleviate disproportionate caregiving responsibilities among female employees, consequently mitigating acute blood pressure fluctuations during shifts.²²

To mitigate the adverse health effects of shift work disorder, a comprehensive intervention strategy is proposed. Firstly, it is recommended that workers with more than five years of night shift exposure undergo annual polysomnography screenings. REM sleep suppression has been identified as a key biomarker for hypertension risk. Additionally, hospitals should incorporate Cognitive Behavioral Therapy for Insomnia (CBT-I) into their occupational health programs. These modules should be tailored to address the disrupted sleep-wake cycles of shift workers.²³

Ergonomic adjustments should also be made, such as rescheduling medication administration to avoid circadian nadirs (2:00–4:00 AM). This could help reduce medical errors caused by impaired vigilance. Technological solutions, like wearable devices providing real-time heart rate variability (HRV) feedback, can assist workers in monitoring their autonomic stress thresholds.²⁴

Architecturally, workspaces should be equipped with dynamic LED lighting systems that mimic natural solar spectra. This can enhance the efficacy of melatonin suppression. From a legislative standpoint, classifying night shifts as an "occupational hazard" could encourage shift trading among workers with compatible chronotypes.

These interventions highlight a systems biology approach, addressing molecular factors (e.g., PER2 gene expression), physiological issues (blood pressure dysregulation), and sociostructural dimensions (gender disparities). Future research should utilize actigraphy-coupled metabolomic profiling to better understand how chronic sleep restriction contributes to cardiometabolic risk in this population.²⁵

5.2. Limitations

The cross-sectional design of primary studies prevents causal inferences from being made about chronic disease trajectories. Self-reported sleep data are susceptible to recall bias, especially in populations with distorted time perception caused by sleep deprivation. Additionally, the homogeneity of healthcare worker cohorts restricts the generalizability of the findings to industries with varying physical demands, such as manufacturing. Although blood pressure measurements are standardized, they may not reflect microvascular stress responses that are only detectable through 24-hour ambulatory monitoring.

5.3. Clinical Policy Implications

First, it recommends reclassifying night shift work as an occupational hazard. This is due to a clear link between night shifts, blood pressure changes, and disruptions in

REM sleep. Such a legal classification would allow health ministries to enforce protections, like limiting consecutive night shifts, ensuring recovery periods, and providing health screenings for heart health.

Secondly, the study suggests implementing "chronotype-aligned" scheduling. This means adopting forward-rotating shifts (from morning to evening to night) instead of static or backward-rotating schedules, as these align better with natural human biological rhythms. Policies should also consider employees' sleep preferences when scheduling shifts to reduce stress and enhance patient safety.

Thirdly, the study emphasizes the need for gender-responsive workplace support, focusing on female healthcare workers who deal with the dual pressures of shifts and caregiving. It suggests that policies should provide on-site or subsidized childcare options and introduce flexible shift-swapping for parents to lessen their stress and improve sleep quality.

Fourthly, there is a call for mandatory health screenings and the integration of light therapy to address sleep issues. The study highlights the relationship between wake time and blood pressure and recommends using bright light therapy to counteract melatonin suppression. Institutions should install specialized lighting in work areas and develop a protocol for monitoring the health of shift workers.

Lastly, it suggests including "Circadian Literacy" in medical education, as higher education impacts views on shift work but not its physiological effects. Training should cover sleep hygiene, the risks of sleep inertia, and the biological mechanisms of shift work disorders.

6. Conclusion

The synthesis of empirical findings from multiple studies underscores the profound physiological and psychosocial consequences of night shift work, especially in healthcare settings. Key findings reveal that circadian misalignment persists due to fragmented sleep architecture, with 43% of night workers reporting insomnia, a phenomenon largely driven by behavioral factors rather than inherent sleep pathology. Notably, gender-specific vulnerabilities emerge, with women disproportionately affected by sociobiological stressors such as caregiving responsibilities, exacerbating autonomic dysfunction (evidenced by elevated systolic blood pressure in female shift workers). The meta-analysis data further corroborate these trends, demonstrating a 2.52 mmHg increase in systolic blood pressure among permanent night shift workers, with mechanistic pathways implicating sympathetic overactivation and attenuated heart rate variability. These outcomes are compounded by familial spillover effects, as evidenced by disrupted sleep synchrony in households with night-shift-working mothers.

Research Highlights

What Is Already Known?

Gender differences in circadian dysregulation among night shift workers are notable, influenced by biological, sociocultural, and policy factors. Mothers on night shifts report shorter sleep, affecting their children, while day-shift families maintain synchronized schedules. Night workers often suffer from sleep disruption, with naps substituting for restorative sleep. Countermeasures include bright light exposure and melatonin. Research indicates night workers have higher insomnia rates and blood pressure issues, especially among women, emphasizing the need for tailored interventions and policy reforms for better health outcomes.

What Does This Study Add?

Analysis of demographic variables (gender, age, marital status, number of children, education level, blood pressure) and Likert-scale items on attitudes yielded predominantly small correlations. Specifically, gender showed a small negative correlation with resistance to altering routines ($r = -0.102$, $P = 0.037$), indicating a preference for stability among women. The number of children correlated negatively ($r = -0.113$, $P = 0.014$), while higher education levels were associated with a reduced desire for a fixed life plan ($r = -0.095$, $P = 0.043$). Blood pressure correlations were minimal, and demographic effects on sleep-related variables were also limited. A correlation was found between blood pressure and wake time ($r = 0.114$, $P = 0.014$), underscoring the stronger influence of biological factors on sleep behaviors.

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Author Contributions

Authors contributed equally to this study.

Declaration of Generative AI and AI-assisted technologies

The authors used ChatGPT to improve the language and readability of the manuscript and subsequently reviewed and edited the text, retaining full responsibility for its content.

Conflict of Interest Disclosures

All authors declared that they have no conflict of interest.

Ethical Approval

This article is based on the research project titled "A Study on the Association Between Personality Factors and Shift Work-Related Health Problems in Behbahan Hospitals," with tracking code 99068 and ethics approval IR.BHN.REC.1400.010. The study has been approved by the Ethics Committee and Research Council of Behbahan Faculty of Medical Sciences.

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