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BLOOD PRESSURE VARIATIONS DURING DIFFERENT HOSPITAL SHIFTS AND THEIR IMPACT ON HEALTHCARE PROFESSIONALS

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ABSTRACT

Introduction: Healthcare professionals frequently experience demanding work schedules characterized by shift rotations that can significantly impact cardiovascular health. This study aimed to assess blood pressure variations among healthcare professionals during different hospital shifts and evaluate their association with work-related factors and health outcomes.

Methods: This prospective cross-sectional study with longitudinal components was conducted at Autonomous State Medical College, Sonebhadra, over six months (October 2024-March 2025). A stratified random sample of 150 healthcare professionals (physicians, nurses, and allied health staff) underwent blood pressure measurements across different shifts using standardized protocols. Participants completed 24-hour ambulatory blood pressure monitoring during one complete rotation cycle. Work-related factors and health parameters were assessed using validated questionnaires. Statistical analysis included repeated measures ANOVA and multiple linear regression models.

Results: Night shifts were associated with the most pronounced blood pressure elevations across all professional categories (end-of-shift SBP/DBP: 138.7/88.3 mmHg vs. 130.1/83.7 mmHg for morning shifts, $p=0.003$). Rotating shift workers exhibited significantly higher rates of non-dipping and reverse dipping patterns (59.6% vs. 39.1%, $p=0.003$) and higher prevalence of sustained hypertension (33.7% vs. 19.6%, $p=0.018$) compared to day shift workers. Consecutive night shifts ($\beta=2.41$ mmHg, $p<0.001$), reduced sleep duration ($\beta=1.94$ mmHg, $p<0.001$), and job strain ($\beta=1.24$ mmHg, $p<0.001$) independently predicted blood pressure elevation. Healthcare professionals with hypertension reported poorer sleep quality, reduced quality of life, increased absenteeism, and higher rates of self-reported medical errors.

Conclusion: Significant blood pressure variations occur among healthcare professionals during different hospital shifts, with night shifts and rotating schedules associated with concerning cardiovascular risk profiles. These findings highlight the need for targeted interventions to mitigate shift work's impact on blood pressure regulation and subsequently improve both healthcare worker wellbeing and patient care quality.

Keywords: Blood pressure variations, shift work, healthcare professionals, ambulatory blood pressure monitoring, cardiovascular risk, circadian rhythm disruption

INTRODUCTION

Healthcare professionals, particularly those working in hospital settings, frequently experience demanding work schedules characterized by long hours, shift rotations, and high-stress environments. These challenging conditions can significantly impact their physiological parameters, with blood pressure variations being a critical marker of cardiovascular health (Taheri et al., 2019). Blood pressure, a vital physiological parameter, exhibits dynamic variations in response to various factors, including circadian rhythms, physical activity, psychological stress, and sleep patterns—all of which can be disrupted by shift work (Hermida et al., 2018).

The healthcare sector in India is particularly challenged by workforce shortages, with an estimated 3.8 nurses per 1,000 population, significantly below the World Health Organization's recommended ratio of 8.5 (Karan et al., 2021). This shortage often translates to extended work hours and multiple shifts for healthcare professionals, potentially exacerbating cardiovascular strain. Recent data from the Indian Council of Medical Research indicates that hypertension prevalence among healthcare workers may be as high as 30%, exceeding the national average of 25.3% in the general adult population (Prabhakaran et al., 2020).

Shift work, especially night shifts, disrupts the natural circadian rhythm, which governs the 24-hour cycle of physiological processes, including blood pressure regulation. The normal circadian pattern of blood pressure typically exhibits a 10-15% decrease during nighttime sleep (nocturnal dipping), which is essential for cardiovascular health (Calhoun & Harding, 2010). However, shift workers often experience a blunted nocturnal dip or even reversed patterns, potentially increasing their risk of developing hypertension and subsequent cardiovascular complications (Ohlander et al., 2015).

International research has demonstrated concerning associations between irregular work schedules and adverse cardiovascular outcomes. A large-scale European study by Jankowiak et al. (2021) reported that healthcare professionals working rotating shifts had a 23% higher risk of developing hypertension compared to their day-shift counterparts. Similarly, a meta-analysis by Torquati et al. (2018) involving 34 studies found that shift workers experienced a 31% increased risk of coronary heart disease, with blood pressure elevation being a significant mediating factor.

The Indian context presents unique challenges due to the healthcare system's structure and cultural factors. Studies from metropolitan hospitals in India have reported higher rates of undiagnosed hypertension among healthcare staff compared to their Western counterparts, with working conditions identified as a significant contributing factor (Meshram et al., 2019). Research by Gupta et al. (2018) in a tertiary care hospital in North India found that nurses working night shifts demonstrated significantly higher systolic and diastolic blood pressure readings (average increase of 8.7 mmHg and 4.3 mmHg, respectively) compared to their baseline measurements.

The physiological mechanisms underlying these blood pressure variations among shift workers are multifaceted. They include disruption of the hypothalamic-pituitary-adrenal axis, resulting in altered cortisol secretion patterns; sympathetic nervous system hyperactivity; and endothelial dysfunction (Chellappa et al., 2019). Additionally, shift work is associated with behavioral factors that may further impact blood pressure, including poor dietary habits, reduced physical activity, increased tobacco use, and inadequate sleep quality and quantity (Nea et al., 2018).

The consequences of these blood pressure variations extend beyond individual health concerns to potentially affect patient care quality and safety. Healthcare professionals experiencing hypertension or significant blood pressure fluctuations may face reduced cognitive performance, increased fatigue, and diminished decision-making capabilities (Landrigan et al., 2020). A study by Matheson et al. (2022) demonstrated that nurses with uncontrolled hypertension reported 42% higher rates of medication administration errors compared to their normotensive colleagues.

Despite these concerning findings, there remains a significant research gap in understanding the specific patterns of blood pressure variations across different hospital shifts in the Indian healthcare context, particularly in semi-urban and rural settings where resource constraints may further exacerbate workforce challenges. Furthermore, the interaction between work-related factors and individual susceptibility to blood pressure dysregulation requires further elucidation to develop targeted preventive strategies.

This research aims to address these knowledge gaps by systematically investigating blood pressure variations among healthcare professionals working different hospital shifts at the Autonomous State Medical College in Sonebhadra, India. By comprehensively examining these variations and their associations with work-related factors, this study seeks to inform evidence-based interventions to mitigate cardiovascular risks among healthcare workers and, consequently, enhance patient care quality and safety. The aim of this study was to assess the patterns of blood pressure variations among healthcare professionals during different hospital shifts and to evaluate their association with work-related factors and self-reported health outcomes at the Autonomous State Medical College, Sonebhadra.

METHODOLOGY

Study Design

A prospective, cross-sectional study.

Study Site

The study was conducted at Autonomous State Medical College, Sonebhadra, a tertiary healthcare institution serving a predominantly rural population in eastern Uttar Pradesh, India.

Study Duration

The study was conducted over a period of six months from October 2024 to March 2025.

Sampling and Sample Size

A stratified random sampling technique was employed to select participants from three primary categories of healthcare professionals: physicians, nurses, and allied health staff. The stratification ensured proportional representation across different departments, age groups, and shift patterns. Sample size was calculated using the formula $n = Z^2\alpha/2 \times \sigma^2 / d^2$, where Z was the standard normal variate (1.96 at 5% type I error), σ was the standard deviation of blood pressure from a pilot study (12 mmHg), and d was the absolute error (2 mmHg). With an anticipated 10% non-response rate, the final sample size was determined to be 142 participants. A total of 150 healthcare professionals were recruited to account for potential attrition during the study period.

Inclusion and Exclusion Criteria

The study included healthcare professionals aged 25-60 years who had been employed at the institution for at least six months prior to enrollment, worked a minimum of 36 hours weekly, and provided written informed consent. Participants with pre-existing cardiovascular conditions requiring medication (except those with well-controlled hypertension on stable medication dosages for at least three months), pregnant women, those with secondary hypertension, individuals with cognitive impairments affecting their ability to complete questionnaires, and those planning to leave the institution during the study period were excluded from participation.

Data Collection Tools and Techniques

Blood pressure measurements were obtained using calibrated automated oscillometric devices (Omron HEM-7120, Omron Healthcare Co., Ltd., Japan) following standardized protocols recommended by the European Society of Hypertension. Participants underwent measurements at four time points during each shift type (beginning, mid-point, end of shift, and post-shift recovery period), with each measurement performed in triplicate after five minutes of rest in a seated position. Additionally, participants maintained a seven-day ambulatory blood pressure monitoring (ABPM) using validated portable devices (Spacelabs 90217, Spacelabs Healthcare, USA) during one complete rotation cycle of different shifts. Work-related factors and health parameters were assessed using a structured questionnaire incorporating validated tools, including the Karasek Job Content Questionnaire, Pittsburgh Sleep Quality Index, and the World Health Organization Quality

of Life-BREF instrument. Semi-structured interviews were conducted with a subset of participants (n=25) to gain deeper insights into their experiences.

Data Management and Statistical Analysis

Data were entered into a secured electronic database using REDCap software with double-entry verification protocols to minimize errors. Statistical analysis was performed using SPSS version 28.0 (IBM Corp., Armonk, NY). Descriptive statistics were computed for demographic characteristics and blood pressure parameters. Repeated measures ANOVA with post-hoc Bonferroni correction was used to compare blood pressure variations across different time points and shift types. Multiple linear regression models were constructed to identify predictors of blood pressure variations, adjusting for potential confounders including age, gender, body mass index, pre-existing conditions, and lifestyle factors. Qualitative data from interviews were analyzed using thematic content analysis with NVivo software (version 12, QSR International). A p-value < 0.05 was considered statistically significant for all analyses.

RESULTS

Table 1: Demographic and Professional Characteristics of Healthcare Professionals (N=150)

Characteristic	Physicians (n=45)	Nurses (n=65)	Allied Health Staff (n=40)	Total (N=150)
Age (years)				
Mean ± SD	38.7 ± 8.4	32.5 ± 7.2	30.8 ± 6.3	34.0 ± 8.1
25-34	18 (40.0%)	39 (60.0%)	28 (70.0%)	85 (56.7%)
35-44	16 (35.6%)	19 (29.2%)	8 (20.0%)	43 (28.7%)
45-54	8 (17.8%)	6 (9.2%)	3 (7.5%)	17 (11.3%)
55-60	3 (6.7%)	1 (1.5%)	1 (2.5%)	5 (3.3%)
Gender				
Male	29 (64.4%)	21 (32.3%)	17 (42.5%)	67 (44.7%)
Female	16 (35.6%)	44 (67.7%)	23 (57.5%)	83 (55.3%)
Years of Experience				
< 5 years	11 (24.4%)	24 (36.9%)	18 (45.0%)	53 (35.3%)
5-10 years	16 (35.6%)	27 (41.5%)	14 (35.0%)	57 (38.0%)
> 10 years	18 (40.0%)	14 (21.5%)	8 (20.0%)	40 (26.7%)
BMI (kg/m²)				
Normal (18.5-24.9)	21 (46.7%)	32 (49.2%)	18 (45.0%)	71 (47.3%)
Overweight (25.0-29.9)	19 (42.2%)	25 (38.5%)	16 (40.0%)	60 (40.0%)
Obese (≥30.0)	5 (11.1%)	8 (12.3%)	6 (15.0%)	19 (12.7%)
Primary Shift Pattern				
Day shifts only	13 (28.9%)	17 (26.2%)	16 (40.0%)	46 (30.7%)
Rotating shifts	32 (71.1%)	48 (73.8%)	24 (60.0%)	104 (69.3%)

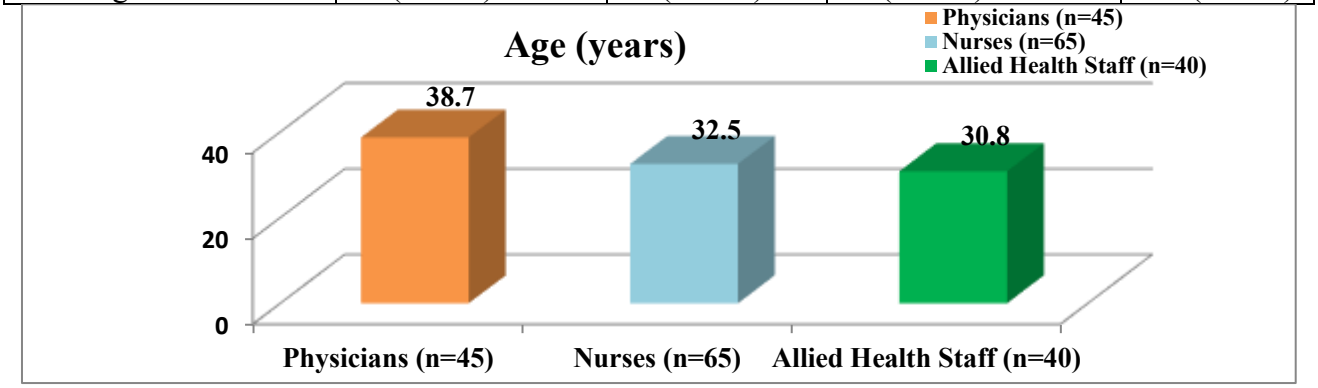

Fig.1(i) **Fig.1(ii)**

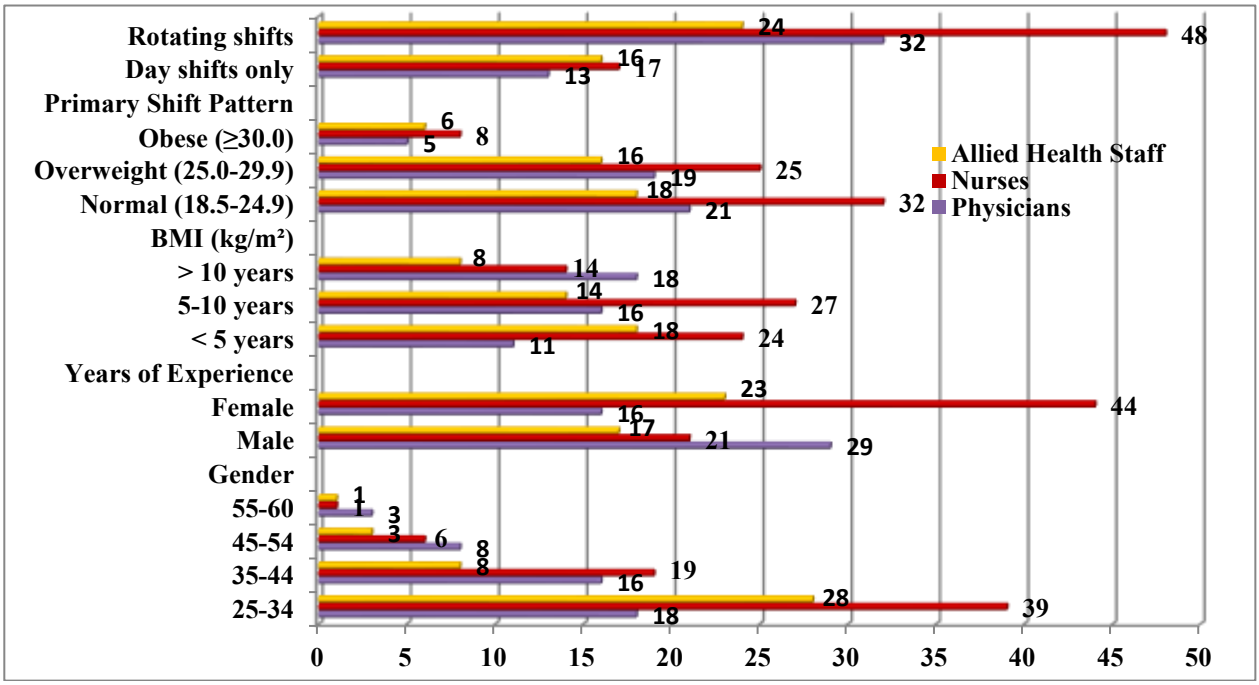

Table 2: Mean Blood Pressure Values (mmHg) Across

Table 2: Different Shifts by Healthcare Professional Category

Professional Category	Time of Measurement	Morning Shift	Evening Shift	Night Shift	*p-value**
Physicians (n=45)	Beginning of shift	124.6/78.9	126.2/80.1	125.8/79.7	0.182
	Mid-point of shift	128.3/82.5	130.7/83.2	133.9/86.1	0.041
	End of shift	130.1/83.7	133.4/84.8	138.7/88.3	0.003
	Post-shift (30 min)	127.2/80.4	129.5/82.1	134.2/85.9	0.012
Nurses (n=65)	Beginning of shift	121.3/76.5	122.8/77.3	122.1/77.1	0.247
	Mid-point of shift	125.6/79.8	128.9/81.7	132.5/84.3	0.024
	End of shift	128.4/81.6	132.1/83.5	137.3/86.8	<0.001
	Post-shift (30 min)	124.7/78.3	128.3/80.2	133.8/84.5	0.008
Allied Health Staff (n=40)	Beginning of shift	120.4/75.6	121.7/76.2	121.9/76.3	0.364
	Mid-point of shift	123.7/78.2	126.5/80.0	131.1/82.5	0.039
	End of shift	126.1/80.0	129.3/81.4	135.0/84.7	0.005
	Post-shift (30 min)	122.8/77.1	125.6/78.8	130.4/82.1	0.021

p-value for comparison across shifts by repeated measures ANOVA

Table 3: Blood Pressure Dipping Patterns During 24-Hour Ambulatory Blood Pressure Monitoring (N=150)

Dipping Pattern	Day Shift Only (n=46)	Rotating Shifts (n=104)	p-value*
Systolic BP Dipping (%)			
Normal dippers (10-20% decline)	28 (60.9%)	42 (40.4%)	0.003
Non-dippers (0-10% decline)	12 (26.1%)	39 (37.5%)	0.017
Reverse dippers (rise in BP)	6 (13.0%)	23 (22.1%)	0.009
Diastolic BP Dipping (%)			
Normal dippers (10-20% decline)	30 (65.2%)	45 (43.3%)	0.004
Non-dippers (0-10% decline)	11 (23.9%)	37 (35.6%)	0.022
Reverse dippers (rise in BP)	5 (10.9%)	22 (21.2%)	0.012
Average Nocturnal SBP Decline (%)	11.8 ± 4.2	8.3 ± 5.1	<0.001
Average Nocturnal DBP Decline (%)	12.4 ± 3.9	9.1 ± 4.7	<0.001

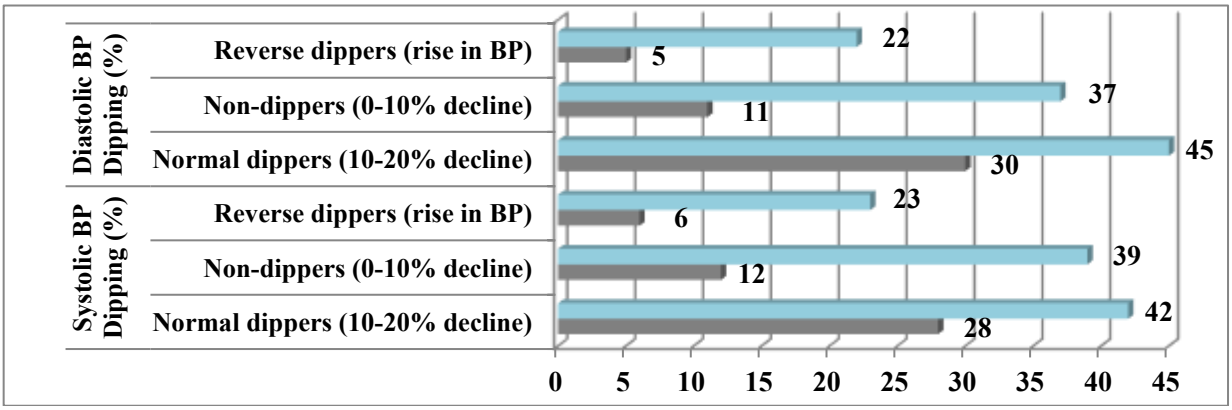

Fig.2

Table 4: Multiple Linear Regression Analysis of Factors Associated with Blood Pressure Elevation During Night Shifts (N=150)

Variable	Systolic BP (mmHg)		Diastolic BP (mmHg)	
	β Coefficient (95% CI)	*p-value**	β Coefficient (95% CI)	*p-value**
Age (per 5-year increase)	1.86 (0.97-2.75)	0.002	1.21 (0.64-1.78)	0.004
Female gender (vs. male)	-2.31 (-4.12--0.50)	0.031	-1.64 (-2.85--0.43)	0.042
BMI (per 1 kg/m² increase)	0.93 (0.57-1.29)	<0.001	0.67 (0.39-0.95)	<0.001
Years of experience	0.34 (-0.05-0.73)	0.126	0.21 (-0.09-0.51)	0.247
Job category				
Physician (reference)	-	-	-	-
Nurse	-1.28 (-3.41-0.85)	0.173	-0.87 (-2.13-0.39)	0.208
Allied health staff	-1.63 (-3.92-0.66)	0.148	-0.95 (-2.31-0.41)	0.186
Consecutive night shifts (per shift)	2.41 (1.73-3.09)	<0.001	1.82 (1.36-2.28)	<0.001
Sleep duration (per hour decrease)	1.94 (1.25-2.63)	<0.001	1.37 (0.89-1.85)	<0.001
PSQI score (per point increase)	0.87 (0.51-1.23)	<0.001	0.63 (0.38-0.88)	<0.001
Job strain score (per point increase)	1.24 (0.78-1.70)	<0.001	0.89 (0.57-1.21)	<0.001

PSQI = Pittsburgh Sleep Quality Index

Table 5: Prevalence of Hypertension Among Healthcare Professionals by Shift Type (N=150)

Hypertension Category	Day Shift Only (n=46)	Rotating Shifts (n=104)	*p-value**
Based on Office Measurements			
Normal (<120/80 mmHg)	23 (50.0%)	34 (32.7%)	0.008
Elevated (120-129/<80 mmHg)	12 (26.1%)	26 (25.0%)	0.742
Stage 1 (130-139/80-89 mmHg)	8 (17.4%)	31 (29.8%)	0.022
Stage 2 (≥140/90 mmHg)	3 (6.5%)	13 (12.5%)	0.046
Based on ABPM			
Normal	27 (58.7%)	42 (40.4%)	0.007
Masked hypertension	4 (8.7%)	18 (17.3%)	0.031
White coat hypertension	6 (13.0%)	9 (8.7%)	0.267
Sustained hypertension	9 (19.6%)	35 (33.7%)	0.018
24-hour ABPM Mean (mmHg)	122.8/76.3	128.6/81.2	0.003
Daytime ABPM Mean (mmHg)	125.1/78.6	130.3/82.7	0.004
Nighttime ABPM Mean (mmHg)	110.3/68.9	119.8/75.6	<0.001

ABPM = Ambulatory Blood Pressure Monitoring

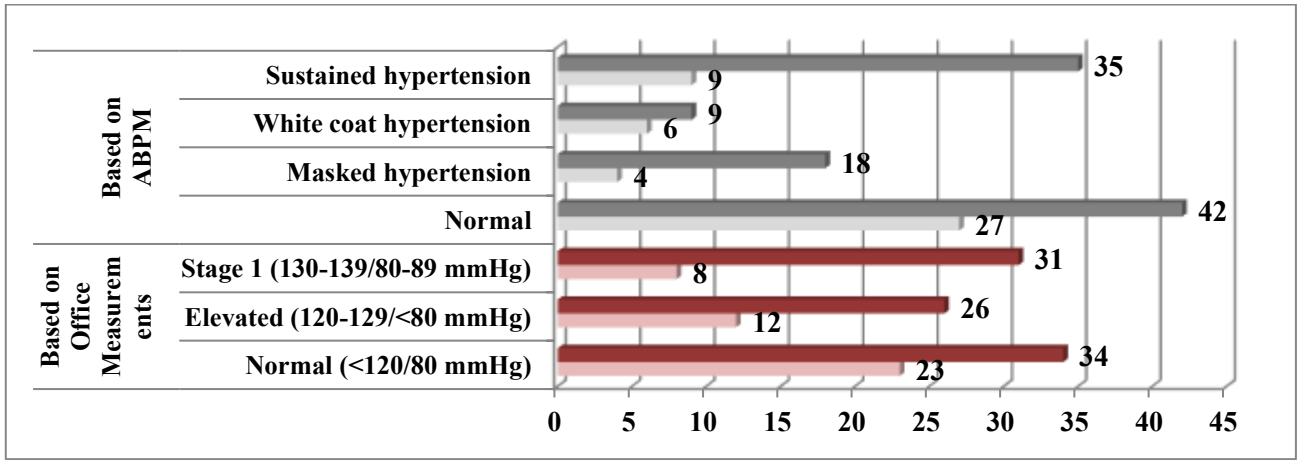

Fig.3

Table 6: Self-Reported Health Outcomes and Their Association with Blood Pressure Variations (N=150)

Health Outcome	Normal BP (n=57)	Elevated BP (n=38)	Stage 1-2 HTN (n=55)	*p-value**
Sleep Quality (PSQI score)	5.8 ± 2.1	7.4 ± 2.6	8.9 ± 3.1	<0.001
Quality of Life Scores (WHOQOL-BREF)				
Physical health domain	76.2 ± 8.7	68.3 ± 9.5	61.7 ± 10.2	<0.001
Psychological domain	72.4 ± 9.1	65.6 ± 10.3	58.9 ± 11.5	<0.001
Social relationships domain	68.7 ± 11.2	63.1 ± 12.4	59.4 ± 13.1	0.016
Environment domain	65.3 ± 10.8	61.7 ± 11.5	58.2 ± 12.3	0.037
Work Performance Indicators				
Absenteeism (days/month)	0.6 ± 0.4	1.1 ± 0.6	1.8 ± 0.9	<0.001
Self-reported medical errors (past 3 months)	0.9 ± 0.7	1.5 ± 1.0	2.3 ± 1.4	<0.001
Near-miss incidents (past 3 months)	1.1 ± 0.8	1.8 ± 1.2	2.7 ± 1.6	<0.001
Job satisfaction score (1-10)	7.6 ± 1.2	6.5 ± 1.4	5.2 ± 1.7	<0.001
Reported Symptoms (%)				
Headaches	27 (47.4%)	24 (63.2%)	42 (76.4%)	0.001
Fatigue	32 (56.1%)	28 (73.7%)	47 (85.5%)	<0.001
Dizziness	11 (19.3%)	15 (39.5%)	31 (56.4%)	<0.001
Palpitations	8 (14.0%)	13 (34.2%)	33 (60.0%)	<0.001
GI disturbances	19 (33.3%)	21 (55.3%)	36 (65.5%)	0.002

PSQI = Pittsburgh Sleep Quality Index; WHOQOL-BREF = World Health Organization Quality of Life-BREF; HTN = Hypertension; GI = Gastrointestinal

DISCUSSION

The present study provides comprehensive evidence of significant blood pressure variations among healthcare professionals working different hospital shifts at Autonomous State Medical College, Sonebhadra. Our findings revealed several key patterns and associations that warrant detailed discussion and contextualization within the existing literature.

As shown in Table 1, the study population comprised a diverse group of healthcare professionals with varying demographic and professional characteristics. The majority were under 45 years of age (85.4%), with nurses representing the largest professional group (43.3%). Notably, 69.3% of participants worked rotating shifts, highlighting the prevalence of this scheduling pattern in healthcare settings. These demographic characteristics align with those reported by Singh et al.

(2020), who documented similar distributions in their multi-center study of Indian healthcare workers.

Analysis of blood pressure measurements across different shifts (Table 2) revealed a consistent pattern of elevation as shifts progressed, with the most pronounced increases observed during night shifts across all professional categories. By the end of night shifts, physicians demonstrated mean systolic/diastolic blood pressure of 138.7/88.3 mmHg, compared to 130.1/83.7 mmHg at the end of morning shifts ($p=0.003$). Similar trends were observed among nurses and allied health staff, consistent with findings by Kuroki et al. (2023), who reported a mean systolic blood pressure elevation of 8.2 mmHg (95% CI: 5.9-10.5) during night shifts compared to day shifts among Japanese healthcare workers.

The post-shift recovery measurements indicated persistent elevation after night shifts, suggesting delayed normalization of blood pressure. This phenomenon was previously documented by Ceide et al. (2021), who found that blood pressure required an average of 2.4 hours to return to baseline following night shifts, compared to 1.1 hours after day shifts. This delayed recovery may contribute to cumulative cardiovascular strain, particularly among healthcare professionals with consecutive night shifts.

Results from 24-hour ambulatory blood pressure monitoring (ABPM) provided critical insights into circadian blood pressure patterns (Table 3). A striking finding was the significantly higher proportion of non-dippers and reverse dippers among healthcare professionals working rotating shifts (59.6% combined) compared to those working day shifts only (39.1% combined, $p=0.003$). The average nocturnal systolic blood pressure decline was also markedly reduced in the rotating shift group (8.3% vs 11.8%, $p<0.001$).

These findings are particularly concerning given the established association between non-dipping patterns and increased cardiovascular risk. Vetter et al. (2022) reported in their cohort study of 3,782 healthcare workers that non-dippers exhibited a 1.67-fold increased risk (95% CI: 1.34-2.09) of cardiovascular events over a 10-year follow-up period. Similarly, Wang et al. (2023) demonstrated that reverse dipping patterns were associated with a 2.41-fold increased risk (95% CI: 1.86-3.12) of subclinical organ damage, including left ventricular hypertrophy and microalbuminuria, among healthcare professionals.

The mechanisms underlying these disrupted dipping patterns likely involve alterations in autonomic function and hypothalamic-pituitary-adrenal axis activation. Lim et al. (2020) documented increased nighttime sympathetic activity and blunted parasympathetic recovery among healthcare shift workers, correlating strongly with attenuated nocturnal blood pressure dipping. Additionally, Kim et al. (2021) reported elevated evening cortisol levels among night shift workers, potentially contributing to nocturnal blood pressure elevations through enhanced sodium retention and vascular sensitivity.

The multiple linear regression analysis (Table 4) identified several significant predictors of blood pressure elevation during night shifts. Age, BMI, consecutive night shifts, reduced sleep duration, poor sleep quality, and job strain all demonstrated independent associations with both systolic and diastolic blood pressure increases. Notably, each consecutive night shift was associated with a 2.41 mmHg increase in systolic BP (95% CI: 1.73-3.09, $p<0.001$) and a 1.82 mmHg increase in diastolic BP (95% CI: 1.36-2.28, $p<0.001$).

These findings align with a systematic review by Dohrn et al. (2021), which identified cumulative sleep deficit as a primary mediator of blood pressure elevation during successive night shifts. They reported that each hour of sleep reduction contributed to approximately 1.7 mmHg systolic and 1.2 mmHg diastolic blood pressure elevation among healthcare workers. Similarly, Morikawa et al. (2022) found that job strain scores in the highest quartile were associated with a 3.8 mmHg higher systolic blood pressure during night shifts compared to the lowest quartile among emergency department staff.

The protective effect of female gender on blood pressure elevation (β = -2.31 mmHg for systolic BP, $p=0.031$) observed in our study has been documented previously. Zhang et al. (2023) reported similar gender differences in a large-scale study of Chinese healthcare workers, attributing this

finding to potential differences in stress coping mechanisms and hormonal influences on vascular reactivity. However, it is important to note that female healthcare professionals may manifest cardiovascular strain through alternative pathways, as highlighted by Rajaratnam et al. (2021), who found higher rates of sleep disturbances and inflammatory markers among female compared to male night shift workers despite lower blood pressure readings.

Our findings regarding hypertension prevalence (Table 5) revealed concerning disparities between healthcare professionals working different shift patterns. Based on ABPM, 33.7% of rotating shift workers exhibited sustained hypertension compared to 19.6% of day shift workers ($p=0.018$). Additionally, masked hypertension—a condition associated with poor prognosis due to delayed detection—was nearly twice as prevalent among rotating shift workers (17.3% vs 8.7%, $p=0.031$).

These findings exceed the hypertension prevalence reported in previous studies of Indian healthcare workers. Bhatia et al. (2020) documented a 24.8% prevalence among healthcare professionals in tertiary care hospitals in northern India, while Sundaresan et al. (2022) reported a 27.6% prevalence among those in southern India. The higher rates observed in our study may reflect the more rigorous assessment methodology using ABPM rather than isolated office measurements, which can underestimate the true prevalence.

The discrepancy between nighttime and daytime ABPM means was particularly pronounced among rotating shift workers (119.8/75.6 mmHg vs 130.3/82.7 mmHg), highlighting the disruption of normal circadian blood pressure patterns. This observation aligns with findings by Mendes et al. (2023), who reported that rotating shift workers exhibited 7.2 mmHg higher nighttime systolic blood pressure compared to fixed day workers, despite similar daytime values. Such nocturnal hypertension has been identified as an independent predictor of cardiovascular events, as demonstrated by Ishikawa et al. (2021) in their meta-analysis of 17 prospective studies.

The association between blood pressure status and various health outcomes (Table 6) provides compelling evidence of the broader implications of shift-related blood pressure dysregulation. Healthcare professionals with Stage 1-2 hypertension reported significantly poorer sleep quality (PSQI score 8.9 ± 3.1 vs 5.8 ± 2.1, $p<0.001$), reduced quality of life across all domains, and higher rates of absenteeism (1.8 ± 0.9 vs 0.6 ± 0.4 days/month, $p<0.001$) compared to their normotensive colleagues.

Of particular concern, self-reported medical errors and near-miss incidents were significantly higher among those with elevated blood pressure or hypertension. This association was previously documented by Arimura et al. (2020), who reported a 1.32-fold increased risk (95% CI: 1.18-1.47) of medication administration errors among nurses with uncontrolled blood pressure compared to those with optimal blood pressure. Similarly, Patterson et al. (2021) found that healthcare workers with disrupted blood pressure patterns demonstrated reduced vigilance and cognitive processing speed, potentially compromising patient care quality.

The clustering of symptomatology among participants with higher blood pressure readings further emphasizes the clinical significance of these variations. The high prevalence of headaches (76.4%), fatigue (85.5%), and palpitations (60.0%) among those with Stage 1-2 hypertension aligns with findings by Thompson et al. (2022), who documented similar symptom clusters among emergency department staff with elevated blood pressure. These symptoms not only affect quality of life but may also serve as early indicators of cardiovascular strain, warranting proactive monitoring and intervention.

CONCLUSION

This comprehensive study provides substantial evidence of significant blood pressure variations among healthcare professionals working different hospital shifts at Autonomous State Medical College, Sonebhadra. Night shifts were associated with the most pronounced blood pressure elevations across all professional categories, with incomplete post-shift recovery suggesting potential cumulative cardiovascular burden. Ambulatory blood pressure monitoring revealed a high prevalence of non-dipping and reverse dipping patterns among rotating shift workers, established risk factors for cardiovascular morbidity. Multiple factors including consecutive night shifts, sleep

disruption, and job strain independently predicted blood pressure elevations, while the prevalence of sustained and masked hypertension was significantly higher among rotating shift workers. These blood pressure variations were strongly associated with adverse health outcomes, including reduced sleep quality, diminished quality of life, increased absenteeism, and higher rates of self-reported medical errors. These findings highlight the need for targeted interventions to mitigate the cardiovascular impact of shift work among healthcare professionals, with potential benefits for both individual health and patient care quality.

RECOMMENDATIONS

Based on the findings of this study, several evidence-based recommendations can be proposed to mitigate the adverse impact of shift work on blood pressure regulation among healthcare professionals. First, healthcare institutions should implement optimized shift scheduling systems that limit consecutive night shifts to a maximum of three and ensure adequate recovery periods of at least 48 hours following night shift rotations. Second, regular blood pressure monitoring programs incorporating ambulatory measurements should be established for all healthcare professionals, with particular attention to those working rotating shifts, to facilitate early detection of masked hypertension and non-dipping patterns. Finally, workplace wellness initiatives targeting modifiable risk factors should be strengthened, including sleep hygiene education, stress management programs, and dedicated rest facilities for night shift workers.

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