

Prevalence of Pre-Hypertension and its Association with Perceived Stress and Sleep Quality among Medical Postgraduates: A Cross-Sectional Study

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ABSTRACT

Background: Pre-hypertension, defined by the Seventh Report of the Joint National Committee (JNC 7) as a systolic blood pressure of 120–139 mmHg or diastolic blood pressure of 80–89 mmHg, has emerged as a significant cardiovascular risk factor. Medical postgraduate residents represent a high-risk occupational cohort exposed to chronic sleep deprivation, high cognitive load, and prolonged work hours. The burden of these stressors and their haemodynamic consequences across departmental subgroups remain poorly characterised.

Objectives: To estimate the prevalence of pre-hypertension and hypertension among medical postgraduates and to determine the association with perceived stress (PSS-10) and sleep quality (PSQI) across pre-clinical, para-clinical, and clinical departmental subgroups.

Materials and Methods: A cross-sectional analytical study was conducted at SVMCH & RC, Puducherry, among 320 medical postgraduate residents. Standardised blood pressure measurements were obtained using a calibrated sphygmomanometer following JNC 7 protocol. Perceived stress and sleep quality were assessed using the Perceived Stress Scale (PSS-10) and the Pittsburgh Sleep Quality Index (PSQI), respectively. Chi-square tests, one-way ANOVA, and Pearson correlation were applied. A p-value < 0.05 was considered statistically significant.

Results: Pre-hypertension was identified in 220 participants (68.8%) and overt hypertension in 61 (19.1%), yielding a combined elevated blood pressure prevalence of 87.8%. Poor sleep quality (PSQI > 5) was present in 89.1% and high perceived stress (PSS-10 > 26) in 40.3%. Clinical postgraduates exhibited significantly higher mean PSS-10 scores (27.99 ± 5.08) and PSQI scores (8.74 ± 2.25) compared with para-clinical and pre-clinical subgroups (p < 0.001). PSS-10 score correlated positively with systolic blood pressure (r = 0.483, p < 0.001) and PSQI score correlated positively with systolic blood pressure (r = 0.471, p < 0.001).

Conclusion: Pre-hypertension is highly prevalent among medical postgraduates, with clinical residents bearing the greatest burden. High perceived stress and poor sleep quality are independently and significantly associated with elevated blood pressure. These findings provide evidence for the implementation of structured resident wellness programmes.

Keywords: Pre-hypertension, medical postgraduates, perceived stress, PSS-10, sleep quality, PSQI, JNC 7, resident wellness

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INTRODUCTION

Hypertension represents the leading modifiable cardiovascular risk factor globally, responsible for an estimated 10.4 million deaths annually. The concept of pre-hypertension, introduced by the JNC 7 in 2003, identifies individuals with systolic blood pressure (SBP) 120–139 mmHg or diastolic blood pressure (DBP) 80–89 mmHg as being at substantially elevated risk of progressing to established hypertension [1].

Medical postgraduate residents are a distinct demographic, defined by strong professional stress, irregular shift-based duties, chronic sleep deprivation, and high performance expectations [2]. It is hypothesized that autonomic dysregulation brought on by these stresses may encourage sympatho adrenal activation, which will cause blood pressure to persistently rise even in the pre-hypertensive range.

Research on cardiovascular outcomes in junior physicians has mostly concentrated on psychosocial endpoints like depression and exhaustion. There are few published studies on the hemodynamic effects of occupational stress in this population, and there hasn't been a comprehensive assessment of the load variation in pre-clinical, para-clinical, and clinical departmental settings in India. According to Sandeep et al. (2025), 28% of South Indian medical students had pre-hypertension; nevertheless, postgraduate residents have far more clinical responsibility and duty-hour obligations [3].

The present study was designed to address this gap by estimating the prevalence of pre-hypertension and hypertension among medical postgraduate residents and by quantifying the association of perceived stress and sleep quality with blood pressure status across departmental subgroups. The findings are intended to inform evidence-based institutional wellness initiatives.

MATERIALS AND METHODS

Study Design and Setting: A cross-sectional analytical study was conducted in the department of general medicine at a Tertiary Care Centre in Puducherry over a three-month study period, following approval from the Institutional Scientific Review Committee (SRC) and the Institutional Ethics Committee (IEC). All participants provided written informed consent prior to data collection.

Sample Size: Sample size was calculated based on a reported pre-hypertension prevalence of 55.6% among medical students (Subramanian et al., 2018), using the formula $N = 4PQ/dZ$ at 95% confidence and 80% power, yielding a minimum of 320 participants [4].

Eligibility Criteria: Inclusion criteria were MD/MS postgraduate residents from pre-clinical, para-clinical, and clinical departments; age ≥ 23 years; first-year residents who had completed at least six months of training and willingness to provide written informed consent. Exclusion criteria were known hypertension currently on antihypertensive medication; pregnancy; secondary causes of hypertension (renal or endocrine disorders) and current use of systemic corticosteroids, stimulants, or neuropsychiatric agents known to affect blood pressure or sleep.

Blood Pressure Measurement: Participants were approached during non-emergency duty hours. Caffeine, smoking, and vigorous exercise were avoided for at least 30 minutes prior to measurement. After a minimum of five minutes of seated rest, two blood pressure readings were recorded at an interval of one to two minutes using a calibrated mercury sphygmomanometer in the right arm, with the participant in the seated position. The average of the two readings was used for classification. JNC 7 criteria were applied: Normal $< 120/80$ mmHg; Pre-Hypertension $120-139 / 80-89$ mmHg; Hypertension $\geq 140/90$ mmHg.

Perceived stress was measured using the 10-item Perceived Stress Scale (PSS-10). Items 4, 5, 7 and 8 were reverse-scored. Total scores range from 0 to 40, classified as low stress (≤ 13), moderate stress (14–26), and high stress (≥ 27). Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) [5]. A global PSQI score > 5 indicates poor sleep quality. Anthropometric measurements (height, weight, body mass index) were recorded using standardised protocols.

STATISTICAL ANALYSIS

Data were entered in Microsoft Excel 2010 and analysed using SPSS version 23.0 (IBM Corporation, Armonk, NY). Continuous variables are expressed as mean $\pm$ standard deviation. Categorical variables are expressed as frequencies and percentages. The chi-square test was used to examine associations between categorical variables. One-way analysis of variance (ANOVA) was used to compare continuous variables across three or more groups. Pearson's correlation coefficient was used to assess linear relationships between continuous variables. A two-tailed p-value < 0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

A total of 320 medical postgraduate residents were enrolled. The mean age was 25.09 ± 1.35 years. The cohort comprised 164 males (51.3%) and 156 females (48.8%). By year of residency, 95 (29.7%) were first-year, 121 (37.8%) second-year, and 104 (32.5%) third-year residents. By departmental subgroup, 180 (56.3%) were from clinical, 85 (26.6%) from para-clinical, and 55 (17.2%) from pre-clinical departments. The mean body mass index (BMI) was 24.53 ± 3.33 kg/m². Family history of hypertension was present in 105 participants (32.8%). Ninety-four participants (29.4%) reported alcohol consumption and 26 (8.1%) were current smokers. Detailed demographic characteristics are presented in Table 1.

Table 1. Demographic and baseline characteristics by departmental subgroup.

Characteristic	Total (N=320)	Pre-clinical (n=55)	Para-clinical (n=85)	Clinical (n=180)
Age, years (mean $\pm$ SD)	25.09 $\pm$ 1.35	24.60 $\pm$ 1.14	24.97 $\pm$ 1.25	25.30 $\pm$ 1.43
Male, n (%)	164 (51.3)	22 (40.0)	42 (49.4)	100 (55.6)
BMI, kg/m ² (mean $\pm$ SD)	24.53 $\pm$ 3.33	22.80 $\pm$ 2.91	24.21 $\pm$ 3.09	25.09 $\pm$ 3.49
Family history of HTN, n (%)	105 (32.8)	12 (21.8)	26 (30.6)	67 (37.2)
Smoker, n (%)	26 (8.1)	2 (3.6)	5 (5.9)	19 (10.6)
Alcohol consumer, n (%)	94 (29.4)	10 (18.2)	22 (25.9)	62 (34.4)
Night duties/month (mean $\pm$ SD)	3.89 $\pm$ 2.73	1.20 $\pm$ 1.20	2.94 $\pm$ 2.10	5.10 $\pm$ 2.74

BMI = body mass index; HTN = hypertension; SD = standard deviation

Blood Pressure Distribution

A total of 87.8% of the 320 participants had increased blood pressure (pre-hypertension and hypertension), with 39 (12.2%) having normal blood pressure, 220 (68.8%) having pre-hypertension, and 61 (19.1%) having established hypertension

(Figure 1). The average SBP and DBP for those with hypertension were 146.8 mmHg and 95.4 mmHg, respectively. The cohort's mean DBP was 83.4 ± 7.9 mmHg, and the mean SBP was 128.6 ± 11.2 mmHg.

Figure 1. Distribution of Blood Pressure Categories among Medical Postgraduates (N=320)

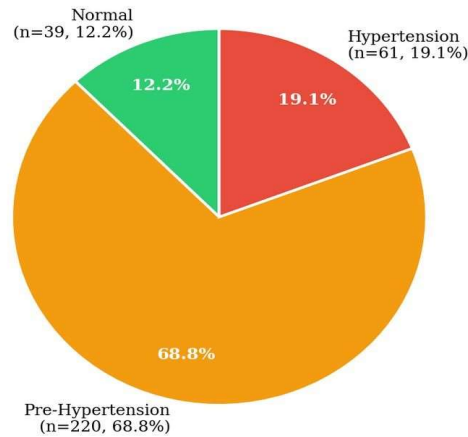


Figure 1: Distribution of blood pressure categories among medical postgraduate residents (N = 320)

Table 2 shows the distribution of blood pressure categories among departmental subgroups. Pre-hypertension (66.7%) and hypertension (27.8%) were much more common among clinical residents than in para-clinical (pre-HTN 75.3%, HTN 8.2%) and

pre-clinical categories (pre-HTN 65.5%, HTN 7.3%). Figure 2 shows that these differences were statistically significant ($\chi^2 = 35.19$, $df = 4$, $p < 0.001$).

Table 2. Blood pressure category distribution by departmental subgroup

BP Category	Pre-clinical (n=55)	Para-clinical (n=85)	Clinical (n=180)	Total (N=320)
Normal, n (%)	15 (27.3)	14 (16.5)	10 (5.6)	39 (12.2)
Pre-Hypertension, n (%)	36 (65.5)	64 (75.3)	120 (66.7)	220 (68.8)
Hypertension, n (%)	4 (7.3)	7 (8.2)	50 (27.8)	61 (19.1)

$\chi^2 = 35.19$, $df = 4$, $p < 0.001$

Figure 2. Blood Pressure Category Distribution by Departmental Subgroup

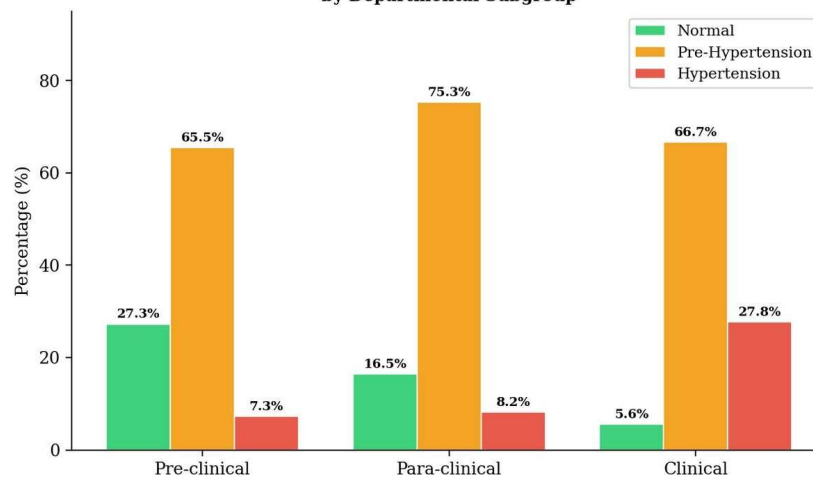


Figure 2: Blood pressure category distribution by departmental subgroup. Chi-square test, $p < 0.001$

Perceived Stress Scale (PSS-10) Findings

The mean PSS-10 score for the entire cohort was 24.98 ± 5.93 . Stress levels were categorised as low in 6 participants (1.9%), moderate in 185 (57.8%), and high in 129 (40.3%). One-way ANOVA demonstrated a significant difference in mean PSS-10 scores across departmental subgroups ($F = 87.50$, $p < 0.001$), with clinical residents exhibiting the highest mean score ($27.99 \pm$

5.08), followed by para-clinical (22.22 ± 4.59) and pre-clinical residents (19.40 ± 3.90 ; Figure 6). The association between stress category and blood pressure category was statistically significant ($\chi^2 = 47.25$, $df = 4$, $p < 0.001$). Among participants with high stress, 34.1% had established hypertension and 62.8% had pre-hypertension (Table 3; Figure 3).

Table 3. Association between perceived stress category (PSS-10) and blood pressure category

Stress Category (PSS-10)	Normal n (%)	Pre-HTN n (%)	HTN n (%)	Total
Low (≤ 13)	3 (50.0)	3 (50.0)	0 (0.0)	6
Moderate (14–26)	32 (17.3)	136 (73.5)	17 (9.2)	185
High (≥ 27)	4 (3.1)	81 (62.8)	44 (34.1)	129
$\chi^2 = 47.25$, $df = 4$, $p < 0.001$				

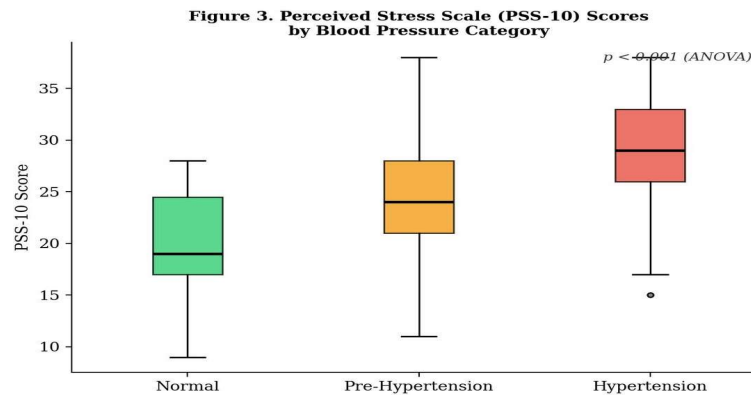


Figure 3: Box plot of PSS-10 scores by blood pressure category. Horizontal line = median; box = interquartile range. $p < 0.001$, one-way ANOVA

Pittsburgh Sleep Quality Index (PSQI) Findings

The mean global PSQI score was 8.09 ± 2.24 . Poor sleep quality ($PSQI > 5$) was identified in 285 participants (89.1%). Mean PSQI scores differed significantly across departmental subgroups ($F = 20.92$, $p < 0.001$), with clinical residents recording the highest mean score (8.74 ± 2.25), compared with para-clinical

(7.53 ± 2.03) and pre-clinical residents (6.85 ± 1.73). The association between sleep category and blood pressure category was statistically significant ($\chi^2 = 25.93$, $df = 2$, $p < 0.001$). Among participants with poor sleep, 21.1% had established hypertension and 69.8% had pre-hypertension (Table 4; Figure 4).

Table 4. Association between sleep quality category (PSQI) and blood pressure category

Sleep Category (PSQI)	Normal n (%)	Pre-HTN n (%)	HTN n (%)	Total
Good Sleep ($PSQI \leq 5$)	13 (37.1)	21 (60.0)	1 (2.9)	35
Poor Sleep ($PSQI > 5$)	26 (9.1)	199 (69.8)	60 (21.1)	285
$\chi^2 = 25.93$, $df = 2$, $p < 0.001$				

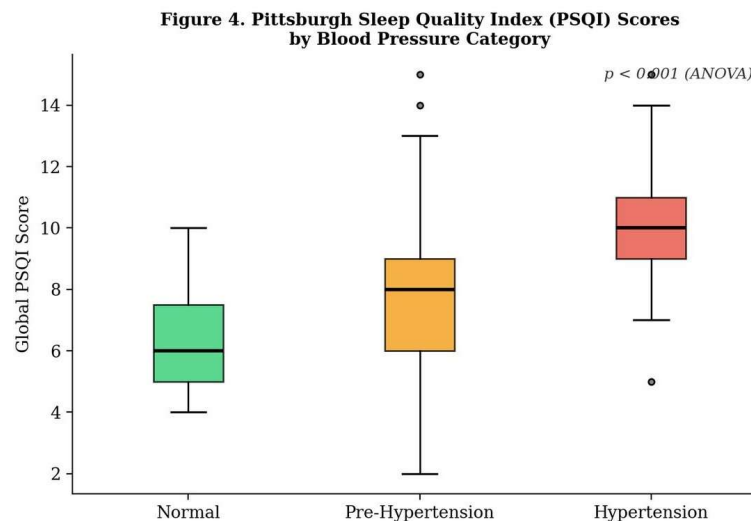


Figure 4: Box plot of global PSQI scores by blood pressure category. $p < 0.001$, one-way ANOVA

Correlation Analysis

Pearson correlation analysis demonstrated significant positive associations between PSS-10 score and mean SBP ($r = 0.483$, $p < 0.001$; Figure 5), PSQI score and mean SBP ($r = 0.471$, $p < 0.001$), and BMI and mean SBP ($r = 0.361$, $p < 0.001$). PSS-10

score and global PSQI score were themselves significantly correlated ($r = 0.528$, $p < 0.001$), indicating that higher perceived stress was associated with poorer sleep quality. Summary correlation coefficients are presented in Table 5.

Figure 5. Correlation between Perceived Stress Score and Systolic Blood Pressure

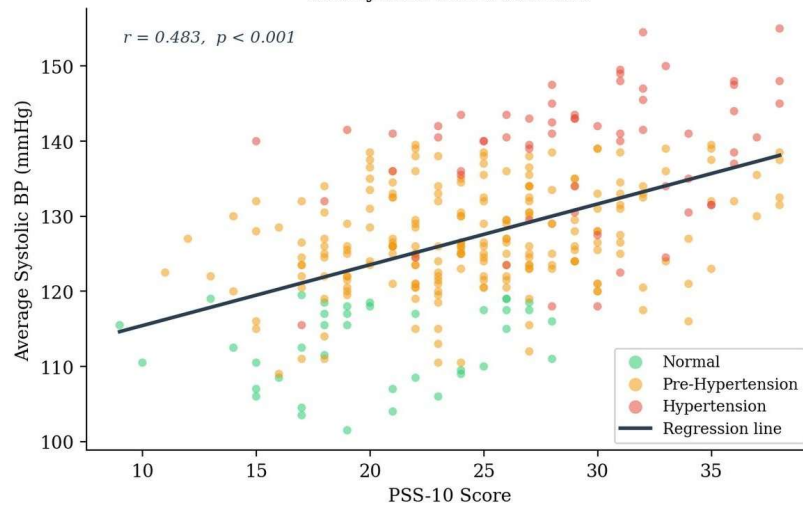


Figure 5: Scatter plot of PSS-10 score against mean systolic blood pressure (mmHg) with regression line. $r = 0.483, p < 0.001$

Table 5. Pearson correlation coefficients between key continuous variables

Variable Pair	r	p-value	Interpretation
PSS-10 Score vs. Systolic BP	0.483	< 0.001	Moderate positive
PSQI Score vs. Systolic BP	0.471	< 0.001	Moderate positive
BMI vs. Systolic BP	0.361	< 0.001	Weak-moderate positive
PSS-10 Score vs. PSQI Score	0.528	< 0.001	Moderate positive

PSS-10 = Perceived Stress Scale; PSQI = Pittsburgh Sleep Quality Index

Figure 6. Mean Perceived Stress Score by Departmental Subgroup

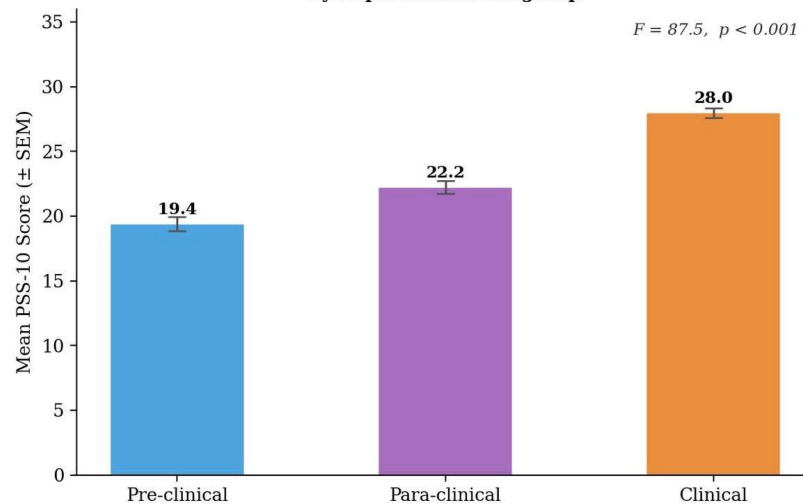


Figure 6: Mean PSS-10 scores (± SEM) by departmental subgroup. One-way ANOVA: $F = 87.5, p < 0.001$

Additional Associations

Gender was significantly associated with blood pressure category ($\chi^2 = 21.08, df = 2, p < 0.001$), with males showing higher rates of hypertension (27.4%) compared with females (10.3%). Family history of hypertension was associated with elevated blood pressure ($\chi^2 = 13.76, df = 2, p = 0.001$). Smoking history was not significantly associated with blood pressure category in this cohort ($\chi^2 = 3.11, df = 2, p = 0.212$). Night duty frequency was significantly higher among participants with hypertension (mean 5.90 ± 2.58 per month) compared with pre-hypertension (3.77 ± 2.72) and normal blood pressure (2.10 ± 2.07).

DISCUSSION

The pre-hypertension prevalence of 68.8% and the combined raised blood pressure prevalence of 87.8% among medical postgraduate residents found in this study are significantly higher than those reported in previous literature for both medical students and general young adult populations. Pre-hypertension prevalence was shown to be 28% among medical students by Sandeep et al. (2025) and 52% among residents during high-duty months by Patel and Sharma (2024) [3,6]. Longer training time, increased clinical exposure, and the buildup of occupational

stressors throughout the residency period may all contribute to the significantly higher prevalence in this study.

The differential burden across departmental subgroups is a novel finding of this study. Clinical residents exhibited the highest proportions of both hypertension and high perceived stress, consistent with their greater night-duty frequency (mean 5.10 per month) and direct patient-care responsibilities. These findings align with the theoretical framework proposed by Hachette et al. (2024), wherein higher stress scores are linearly associated with impaired sleep and increased sleep latency, ultimately driving haemodynamic dysregulation [7,8]. The strong inter-correlation between PSS-10 and PSQI scores ($r = 0.528$, $p < 0.001$) in the present study supports this bidirectional relationship.

The positive correlation between PSS-10 score and systolic blood pressure ($r = 0.483$) is consistent with published evidence. Nguyen et al. (2023) reported that high-stress individuals had a 1.5-fold higher risk of elevated blood pressure compared with low-stress peers [9]. Chronic stress activates the hypothalamic–pituitary–adrenal axis and the sympathetic nervous system, producing sustained catecholamine release and consequent vasoconstriction and cardiac output augmentation. Over time, these episodic haemodynamic perturbations may solidify into persistent pre-hypertension or frank hypertension.

Poor sleep quality was found in 89.1% of participants, much surpassing the 50–70% recorded in general resident surveys. Earlier study by Al-Saadi et al. (2020) reported that getting less than six hours of sleep every night raised the risk of pre-hypertension by 40% [10]. The mean sleep duration in the current study was roughly 5.8 hours, and there was a strong correlation ($r = 0.471$, $p < 0.001$) between the PSQI score and systolic blood

pressure. The observed hemodynamic burden is probably caused by the disturbance of circadian blood pressure dropping that comes with interrupted or reduced sleep.

Gender differences in blood pressure were significant, with males showing higher hypertension rates than females, consistent with established sex-based cardiovascular risk patterns in young adults. Family history of hypertension was also a significant predictor, reinforcing the importance of screening individuals with heritable risk.

The limitations of the present study include its cross-sectional design, which precludes causal inference and the restriction to a single institution. Self-reported questionnaire data are subject to recall bias, and nocturnal blood pressure monitoring was not performed. Longitudinal follow-up studies are needed to determine whether the identified pre-hypertension progresses to established hypertension and whether structured wellness interventions attenuate this trajectory.

CONCLUSION

Pre-hypertension is highly prevalent among medical postgraduate residents with clinical trainees bearing a disproportionate burden attributable to greater occupational stress and sleep deprivation. Perceived stress and poor sleep quality are independently and significantly associated with elevated blood pressure. These findings highlight the urgent need for evidence-based resident wellness programmes, structured duty-hour policies, and periodic cardiovascular screening in medical postgraduate training institutions.

Conflict of Interest: The authors declare no conflict of interest.

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