# A Study of 24 Hours' Ambulatory Blood Pressure among Resident Doctors Working at a Tertiary Care Hospital in Northern India

Kamal Sawlani*
Department of Medicine, Lady Hardinge Medical College and Associated Hospital, Lucknow, India

**ABSTRACT**

Hypertension is a significant global health issue, especially prevalent in developing nations where poor control contributes to the cardiovascular disease epidemic. This study aimed to assess Blood Pressure (BP) and dipping patterns among 159 junior residents from clinical and non-clinical departments using Ambulatory Blood Pressure Monitoring (ABPM). Clinical residents, characterized by longer working hours and reduced sleep, exhibited higher BP and were more prone to non-dipping patterns compared to their non-clinical counterparts. Results showed that 15.1% were true hypertensives, with the majority from clinical departments. Shift work, stress, and sleep deprivation significantly impacted BP variability, making clinical residents vulnerable to hypertension and cardiovascular morbidity. This study underscores the importance of screening, modifying work hours and improving sleep quality to reduce hypertension risk among resident doctors.

**KEYWORDS**
Hypertension, Ambulatory Blood Pressure Monitoring (ABPM), Dipping pattern, Sleep deprivation, Cardiovascular morbidity

*Corresponding Author:
Sawlani K, Department of Medicine, Lady Hardinge Medical College and Associated Hospital, Lucknow, India;
E-mail: kksawlani@gmail.com
How to Cite This Article:

Sawlani K. A Study of 24 Hours' Ambulatory Blood Pressure among Resident Doctors Working at a Tertiary Care Hospital in Northern India. J Evid Based Med Healthc 2025;12(01):1-5.

Received: 03-March-2024;
Manuscript No: JEBMH-24-128717;
Editor assigned: 06-March-2024;
PreQC No. JEBMH-24-128717 (PQ);
Reviewed: 20-March-2024;
QC No. JEBMH-24-128717;
Revised: 03-March-2025;
Manuscript No. JEBMH-24-128717 (R);
Published: 10-March-2025;
DOI: 10.18410/jebmh/2025/12/01/135.

## INTRODUCTION

High Blood Pressure (BP) is currently the greatest threat to the global burden of disease.[1,2] The prevalence of hypertension is increasing rapidly in developing countries, where poor hypertension treatment and control contribute to a growing epidemic of cardiovascular disease. Half of this disease burden occurs in people with hypertension (*i.e.,* BP ≥ 140/90 mmHg); the other half occurs in people with lesser degrees of high BP (prehypertension).[3]

It is well known that BP and heart rate fluctuate over 24 hours. These fluctuations are due to complex internal physiological mechanisms, external stresses and own circadian rhythm attempting to synchronize day and night time BP.[4] Stress can cause hypertension through repetitive BP elevations and through vasoconstriction hormones produced by nervous system.[5]

Ambulatory Blood Pressure Monitoring (ABPM) measures the mean level of BP over prolonged period of time and provides a person's "true" BP. ABPM takes the dynamic BP variations in relation to daily activities (*i.e.,* to changes in physical activity and postures, to location e.g. home versus work, to psychological state and mood, waking versus sleep).[6] Normally nocturnal BP falls between 10%-20% of Mean Arterial Pressure (MAP) and those individuals with nocturnal BP fall <10% are classified as non-dippers and have poorer cardiovascular outcomes.[7] Shift work alters the diurnal variation of BP from a dipper to a non-dipper pattern and increase the risk of hypertension among night shift workers.[8]

Among physicians, BP elevations have been reported during particularly strenuous working conditions such as 24 hours or night shifts in the emergency room, compared to less strenuous periods. Recent studies suggest the prevalence of prehypertension and hypertension is high among medical students.[9,10]

In this study, we included healthy junior residents from various departments of our institute to look for BP and dipping pattern by ABPM and to compare results between residents working in clinical and non-clinical departments.

## MATERIALS AND METHODS

This descriptive cross-sectional study was carried out on 159 subjects in the Department of Medicine, King George Medical University, Lucknow, UP, a tertiary care hospital in Northern India, from September 2018 to August 2019. Ethical clearance was obtained from the Institutional ethical committee.

### Methodology

159 healthy junior residents, 76 from the clinical departments and 83 from the non-clinical departments were recruited in this study. We took BP measurement of clinical residents who had night shift on the next working day. A predesigned and pretested semi-structured questionnaire was used which was filled in an interview-based session by study participants. Each eligible participant was instructed not to take any stimulant (e.g. tea or coffee) before office BP measurement for at least one hour. We noted weekly duty hours of residents as per the schedule and divided residents into two categories, first who were working ≤ 48 hours per week and second those who were working >48 hours per week. We also noted the resident's average sleeping hours per week. Based on guidelines by the American Academy of Sleep Medicine (AASM) and Sleep Research Society (SRS) categorized them into two categories, first with sleeping hours ≥ 49 hours/week and second with <49 hours/week.[11]

### BP Measurement

Office BP was measured using an aneroid sphygmomanometer using the standard protocol. The ABPM was done with the ABPM machine which was programmed to obtain BP every 30 minutes in a day and every hour at night. The participants were educated that the device would repeatedly inflate the cuff and measure BP at regular intervals for over 24 hours. The participants were advised to continue with their normal daily activities and take all their routine medications. When the cuff started to inflate the participants were advised to keep the arm still and relaxed, stop moving and talking and breathe normally during day time. They were advised to avoid activities such as vigorous exercise. They were asked to maintain a brief diary to record the timing of activities, postures, sleep, medications if any, and symptoms (e.g. dizziness) that may be related to BP. We used ESH/ESC 2018 guidelines, to define hypertension, as office Systolic BP (SBP) values >140 mmHg and/or Diastolic BP (DBP) values >90 mmHg, ambulatory 24-hour mean SBP >130 mmHg and/or DBP >80 mmHg, day time mean SBP >135 mmHg and/or DBP >85 mmHg, night time mean SBP >120 and/or DBP >70 mmHg.[12]

### Interpretation of Results

Measurements obtained from ABP monitoring were interpreted by connecting the device with a computer. Based on the readings participants were classified as:

- True hypertensive, white coat hypertensive, masked hypertensive and true normotensive
- Dippers, non-dippers, reverse dippers and extreme dippers[13]

Results obtained in residents working in the clinical department were compared with the residents working in non-clinical departments. The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 24.0.[14]

## RESULTS

The majority of participants were male (73%) with a mean age of 27.86 ± 3.01 years. 37% were overweight, 23% had a family history of hypertension and 11% had a history of either alcohol intake or smoking. All the clinical residents had duty hours >48 hours/week and sleeping hours ≤ 49 hours/week while all the non-clinical residents had duty hours ≤ 48 hours/week and 75.9% had sleeping hours >49 hours/week.[15]

Systolic and diastolic BP pattern of study participants, its association with working hours and sleeping hours and dipping pattern is shown in table 1, 2, 3 and 4 respectively.[16]

| SN | Variable | Clinical residents (n=76) | | Non-clinical residents (n=83) | | p-value |
|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | |
| 1 | Office SBP (mmHg) | 124.66 | 13.79 | 124.89 | 11.35 | 0.907 |
| 2 | 24 hours mean SBP (mmHg) | 120.38 | 9.5 | 115.25 | 10.39 | <0.001 |
| 3 | Day time mean SBP (mmHg) | 121.49 | 11.33 | 121.14 | 13.22 | 0.862 |
| 4 | Night time mean SBP (mmHg) | 112.95 | 11.04 | 106.35 | 9.73 | <0.001 |
| 5 | Office DBP (mmHg) | 77.76 | 8.47 | 76.29 | 6.82 | 0.039 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | 24 hours mean DBP (mmHg) | 75.46 | 7.14 | 68.7 | 9.2 | <0.001 |
| 7 | Day time mean DBP (mmHg) | 77.51 | 7.58 | 69.67 | 9.49 | <0.001 |
| 8 | Night time mean DBP (mmHg) | 69.75 | 8.72 | 65.8 | 9.22 | 0.006 |

**Note:** DBP=Diastolic Blood Pressure, SBP=Systolic Blood Pressure

**Table 1. Systolic and Diastolic BP Pattern of Study Participants (n=159).**

| | | Working hours (per week) | | | | | Sleeping hours (per week) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ≤ 48 hours | | >48 hours | | | ≥ 49 hours | | <49 hours | | |
| SN | Variable | Mean | SD | Mean | SD | p-value | Mean | SD | Mean | SD | P-value |
| 1 | Office SBP (mmHg) | 124.89 | 11.35 | 124.66 | 13.79 | 0.907 | 127.81 | 10.1 | 124.32 | 12.83 | 0.236 |
| 2 | 24 hours mean SBP (mmHg) | 115.25 | 10.39 | 120.38 | 9.5 | <0.001 | 115.47 | 9.58 | 118.82 | 10.46 | 0.052 |
| 3 | Day time mean SBP (mmHg) | 121.14 | 13.23 | 121.49 | 11.33 | 0.862 | 127.16 | 11.08 | 120.05 | 8.38 | 0.079 |
| 4 | Night time mean SBP (mmHg) | 106.35 | 9.73 | 112.95 | 11.04 | <0.001 | 106.71 | 9.62 | 111.33 | 11.28 | 0.008 |
| 5 | Office DBP (mmHg) | 80.29 | 6.82 | 77.67 | 8.47 | 0.039 | 81.52 | 6.48 | 78.71 | 7.86 | 0.121 |
| 6 | 24 hours mean DBP (mmHg) | 68.7 | 9.2 | 75.4 | 7.14 | <0.001 | 68.3 | 8.39 | 73.7 | 8.66 | <0.001 |
| 7 | Day time mean DBP (mmHg) | 69.67 | 9.49 | 77.5 | 7.58 | <0.001 | 70.05 | 8.38 | 73.9 | 9.53 | 0.079 |
| 8 | Night time mean DBP (mmHg) | 65.8 | 9.22 | 69.75 | 8.72 | 0.006 | 65.17 | 8.71 | 69.3 | 9.14 | 0.005 |

**Table 2. Association of Systolic and Diastolic BP Pattern with Working and Sleeping Hours Per Week.**

| | Total (n=159) | | Clinical | Non-clinical |
|---|---|---|---|---|
| | No. | % | % (out of total) | % (out of total) |
| Dipper | 92 | 57.9 | 25 | 75 |
| Non-dipper | 50 | 31.4 | 80 | 20 |
| Reverse dipper | 12 | 7.5 | 83.3 | 16.7 |
| Extreme dipper | 5 | 3.1 | 60 | 40 |

**Table 3. Prevalence of Dipping Pattern in Study Participants.**

| | Mean ± SD (mmHg) | p-value |
|---|---|---|
| Subject | | |
| Clinical (76) | 6.82 ± 6.97 | <0.001 |
| Non-clinical (83) | 11.93 ± 7.78 | |
| Working hours per week | | |
| ≤ 48 hours (83) | 11.93 ± 4.48 | <0.001 |
| >48 hours (76) | 6.82 ± 6.97 | |
| Sleeping hours per week | | |
| ≥ 49 hours (83) | 11.95 ± 4.36 | <0.05 |
| <49 hours (76) | 9.11 ± 6.50 | |

**Table 4. Association of Dipping with Working Hours and Sleeping Hours.**

Out of 159 residents, 93 were true normotensive, 24 were true hypertensives, 8 were white-coat hypertensive and 34 were masked hypertensive. The number of residents having true hypertension, white coat hypertension and masked hypertension were more in clinical group as compared to non-clinical group.[17]

Among study participants, 92 were dipper (including 29 clinical and 63 non-clinical residents), 50 were non-dipper (40 clinical and 10 non-clinical residents), 12 were reverse dipper (10 clinical and 2 non-clinical residents) and 5 were extreme dipper (3 clinical and 2 non-clinical residents).[18]

## DISCUSSION

Hypertension is known as a 'silent killer' as it may have no warning symptoms or signs. Hypertension is a major cause of premature death worldwide. In various previous studies done so far, the high burden of prehypertension and hypertension has been observed among young college students and medical undergraduate students but they used office BP method for BP measurement. We used ABPM along with office measurement in this study to rule out the white coat effect of BP and to find a true prevalence of hypertension in the study group.[19]

In our study 15.1% of residents were found to be 'true hypertensive'. Amitabha Chattopadhyay et al., had found that 13.88%, out of 850 undergraduate medical students, were hypertensive, while 19.18% were prehypertensives. Hussein H Alhawari et al., found that out of 505 university students 35.2% had BP between 130/80 and 139/89 and 13.5% had BP more than 140/90 mmHg. Jolly Bhattacharya and Bobyjeet Goswami found that 68.38% of 136 medical students had prehypertension. Tarun Rao et al., conducted a study among 765 medical students of 17-35 years of age group and found that 3.53% of students were hypertensive and 32.16% of students were prehypertensives. Akhtar A et al., found elevated BP with no prior history of hypertension in 32% of the younger population of aged 30-59 years as compared to 23% in the older population aged >60 years.[20]

These studies suggest that prehypertension and hypertension are being observed in the younger population, so screening of such population specially those who work under stress should be done to detect high BP and its variability.

Out of total true hypertensive in our study, the majority (58.3%) were from clinical group. On comparing systolic BP among clinical and non-clinical residents, 24 h mean ABP, night time mean BP was significantly higher in residents of clinical group ($p<0.001$). However, on comparing office BP and day time mean BP no significant difference was found. On comparing diastolic BP, office, 24 hours mean, day time as well as night time mean BP was found to be significantly raised among residents of clinical group ($p=0.039$, $<0.001$, $<0.001$ and $0.006$ respectively). More prevalence of hypertension among clinical group could be due to effect of stressful environment in clinical settings, long working hours and lesser sleeping hours of residents of clinical group compared to non-clinical group.

The overall prevalence of White Coat Hypertension (WCH) in the general population is 10%-15%. In our study we found that 5% of total residents were white coat hypertensive. Two third of these were from clinical group while one third was from non-clinical group. Treatment decisions based on office BP alone might result in substantial over diagnosis. The long-term outcome of WCH is not clear but most studies agrees that patient of WCH has a higher possibility of progression to sustained hypertension.

21.4% of the total residents were found to have masked

hypertension by ABPM in our study, the majority were from clinical group. These masked hypertensive residents would have missed if ambulatory monitoring had not been done. Moo-Yong Rhee et al in their study found 16.22% of total 496 participants had masked hypertension. In their study the estimated prevalence of masked hypertension was 17.5%, 20.58%, 24.34% and 13.29% in the age categories of 30s, 40s, 50s and 60s, respectively. So screening and periodic monitoring of resident doctors for hypertension should be incorporated at the time of entrance and during their residency period.

Many studies suggest that raised BP and increased risk of cardiovascular disease is associated with long working hours. Residents of clinical department don't have fixed working hours. They have emergency duties, night time duties and shift work. They work in a stressful environment during their emergency duties. 24 hour mean systolic and diastolic BP of the clinical residents were 115.25 ± 10.39 and 68.70 ± 9.20 which were higher as compared to non-clinical group. Similarly, day time mean and night time mean systolic and diastolic BP of clinical residents were found to be higher than that of non-clinical residents. A statistically significant difference ($p<0.05$) was found between long working hours and both systolic and diastolic BP pattern. Kivimaki et al., found that working long hours was associated with an increase in risk of incident coronary artery disease and incident stroke. Similar results were found by Fadel and Lee et al. The resident doctors who have long working hours are prone to develop hypertension and other cardiovascular comorbidities, so working hours of residents should be optimised.

Sleep deprivation has a great effect on cardiovascular regulation through the autonomic nervous system. Cohort studies reported increased incidence of Cardiovascular Diseases (CVD) in short sleepers. In our study, out of 159 total residents, 60.4% had less sleeping hours. All the residents of clinical group had sleeping hours <49 hours/week. The mean sleeping hour of clinical residents (40 ± 3.70) was lesser compared to residents of non-clinical department (51.48 ± 3.70). We found that 24 hour mean systolic BP ($p=0.05$) and night time mean systolic BP ($p=0.008$) was significantly higher in residents with sleeping hours <49 hours/week when compared to residents who had sleeping hours >49 hours/week. However, the difference in office systolic BP and day time mean systolic BP of both the groups were not statistically significant. Similarly, 24 hour mean diastolic BP ($p<0.01$) and night time mean diastolic BP ($p=0.005$) was statistically significantly higher in residents with sleeping hours <49 hours/week when compared to residents who had sleeping hours >49 hours/week. However, the difference in office diastolic BP and day time mean diastolic BP was not statistically significant. Ru-Qing Liu et al., evaluated the association between sleep quality, as determined by the Pittsburgh Sleep Quality Index (PSQI), and hypertension and concluded that the global PSQI score and its components (short sleep duration, poor sleep quality, prolonged sleep latency and sleep disturbance) were associated with high BP. Poor sleep quality and stressful status are closely associated with higher activation of sympathetic nervous system and independent predictors of non-dipping hypertension.

In our study, 57.9% residents had normal dipping pattern of BP while 31.4% residents had non-dipping pattern of BP. Non-dipping pattern was more prevalent in clinical group. Mean of dipping in BP was statistically significantly lower (falling into non-dipper or reverse dipper range) in residents in clinical group ($p<0.001$) when compared to residents in non-clinical group. This dipping pattern in BP was found to be statistically significant in subjects with long working hours ($p<0.001$) as well as with inadequate sleeping hours ($p=0.05$). Huan Yang et al., found in his study that repeated inadequate sleeping blunts sleep associated BP dipping. These non-dipper participants may be at increased risk of hypertension due to repetitive blunting of sleep associated BP dipping and resultant increase in mean circadian BP.

We found in our study that prevalence of raised BP is more among clinical residents and this might be due to their long working hours, less sleeping hours and work-related stress in clinical settings. Presence of these risk factors among clinical residents make them vulnerable for development of hypertension and other cardiovascular comorbidities. So, these risk factors should be reviewed and modified to prevent progression. Working hours of the resident doctor should be rescheduled to allow proper rest. A long duty at a stretch should be discouraged. Proper measures need to be taken to improve sleep time and sleep quality of resident doctors. The number of resident doctors should be raised to overcome poor doctor: Population ratio. Teaching programme to overcome the work-related stress should be introduced. Screening programme to diagnose at risk young doctors should be developed to identify hypertension so that early intervention and other measures can be taken to prevent development of cardiovascular comorbidities. Periodic monitoring of the resident doctors should be done for raised BP.

Whether these residents will develop hypertension in future and whether they should be treated? Whether abnormal dipping pattern will lead to cardiovascular complications? Further research with larger sample size and follow up is required to answer these questions.

The strength of this study can be attributed to the BP measured with validated automatic device.

The main limitations of our study are

- Our study was a single center study.
- Study with larger sample size is required to apply results in whole community.
- This was a cross sectional study and long term follow up of the participants was not done which might affect our results.
- Our study is done in tertiary care referral hospital with average bed occupancy of more than 100% and it may not correlate with other institutions.

## CONCLUSION

Our study concludes that various modifiable risk factors like long working hours, inadequate sleep and work-related stress are significantly present in residents which make them prone to develop hypertension and other cardiovascular comorbidities. Also the prevalence of non-dippers and reverse dippers was found to be higher in clinical residents compared to non-clinical residents making them vulnerable for increased target organ involvement and increased cardiovascular morbidity and mortality. Hence there is an urgent need to improve and modify these work-related risk factors so that these young generation resident doctors could be prevented from falling into the high-risk category for developing hypertension and other cardiovascular comorbidities.

## REFERENCES

1. Horton R. GBD 2010: Understanding disease, injury and risk. Lancet. 2012;380(9859):2053–2054.

2. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2224–2260.
3. Poulter NR, Prabhakaran D, Caulfield M. Hypertension. Lancet. 2015;386(9995):801–812.
4. Chau NP, Mallion JM, de Gaudemaris R, et al. Twenty-four-hour ambulatory blood pressure in shift workers. Circulation. 1989;80(2):341–347.
5. Kulkarni S, O'Farrell I, Erasi M, et al. Stress and hypertension. WMJ. 1998;97(11):34–38.
6. Landsbergis PA, Schnall PL, Belkic KL, et al. Work conditions and masked (hidden) hypertension-Insights into the global epidemic of hypertension. Scand J Work Environ Heal Suppl. 2008:41–51.
7. Mosendane T, Mosendane T, Raal FJ. Shift work and its effects on the cardiovascular system. Cardiovasc J Afr 2008;19(4):210–215.
8. Kitamura T, Onishi K, Dohi K, et al. Circadian rhythm of blood pressure is transformed from a dipper to a non-dipper pattern in shift workers with hypertension. J Hum Hypertens. 2002;16(3):193–197.
9. Nyombi KV, Kizito S, Mukunya D, et al. High prevalence of hypertension and cardiovascular disease risk factors among medical students at Makerere University College of Health Sciences, Kampala, Uganda. BMC Res Notes. 2016;9(1).
10. Bhattacharjya J, Goswami B. Prevalence of prehypertension among the medical students and its correlation with body mass index. Int J Sci Study. 2016;4(7):13–16.
11. Watson NF, Badr MS, Belenky G, et al. Recommended amount of sleep for a healthy adult: A joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. Sleep. 2015;38(8):1161–1183.
12. Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. Eur Heart J. 2018;19(11):3–73.
13. Tadesse T, Alemu H. Hypertension and associated factors among university students in Gondar, Ethiopia: A cross-sectional study. BMC Public Health. 2014;14(1):937.
14. Chattopadhyay A, Taraphdar P, Sahu BK, et al. A study on prevalence of hypertension and its related risk factors among undergraduate medical students in Kolkata. IOSR J Dent Med Sci. 2014;13(11):1–7.
15. Chitrapu R, Thakkallapalli Z. Prehypertension among medical students and its association with cardiovascular risk factors. J Dr NTR Univ Heal Sci. 2015;4(1):8.
16. Mohamed Moussa MM, El-mowafy RI, El-Ezaby HH. Prevalence of hypertension and associated risk factors among university students: Comparative study. J Nurs Educ Pract. 2016;6(5):19–27.
17. Okere OS, Sangodele JO, Adams MD, et al. Epidemic of dengue and dengue hemorrhagic fever in Pakistan. Int J Biomed Res. 2014;5(2013):158–160.
18. Alhawari HH, Al-Shelleh S, Alhawari HH, et al. Blood pressure and its association with gender, body mass index, smoking and family history among university students. Int J Hypertens. 2018;2018:1–5.
19. Alanazi AMJ, Alenezi YM, Alanazi TH. Prehypertension and hypertension in medical students of Northern Border University in Arar, Saudi Arabia. Egypt J Hosp Med. 2018;70(1):33–38.
20. Rao T, Jain J, Chaudhary R. Prevalence and risk factors of hypertension among young medical students: An observational study. Int J Biomed Res. 2017;8(11):609–613.