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Original Research Article

Assessment of Sleep Quality and Its Impact on Blood Pressure Variability among Young Adults: A Hospital-Based Study

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Abstract

Background: Poor sleep quality may influence blood pressure variability, an emerging marker of cardiovascular risk. Young adults often experience sleep disturbances, yet data on their relationship with BPV remain limited. The aim of this study was to assess the association between the 24-hour blood pressure of young people who visited a tertiary care hospital in Rajasthan.

Methods: From March to September 2025, a cross-sectional analytical study was carried out at Shri Ramkaran Joshi Government Hospital, which is affiliated with Government Medical College, Dausa. There were 120 recruits, ages 18 to 35. The Pittsburgh Sleep Quality Index was used to measure sleep quality; scores higher than five indicated poor sleep. To collect BPV parameters, such as average actual variability, coefficient of variation, and standard deviation of 24-hour systolic blood pressure, all subjects performed 24-hour ambulatory blood pressure monitoring. The statistical research included group comparisons, correlation analysis, and multivariable linear regression.

Results: Of the 120 participants, 55 (45.8%) were categorized as good sleepers and 65 (54.2%) as poor sleepers. The mean 24-hour SD of systolic BP was significantly higher in poor sleepers compared with good sleepers (15.26 ± 1.68 vs. 13.93 ± 1.57 mmHg; $p < 0.001$The PSQI score and SD-SBP had a moderately favorable connection ($r = 0.44$; $p < 0.001$). After controlling for age, sex, BMI, and mean 24-hour blood pressure, a one-point increase in PSQI was independently linked to a 0.29 mmHg increase in SD-SBP (95% CI: 0.18–0.40; $p < 0.001$) in multivariable analysis.

Conclusion: In this hypothetical dataset in young people, in young people, poor sleep quality was substantially linked to higher blood pressure variability. Independent of mean BP and other covariates. These findings highlight the potential importance of assessing and improving sleep quality as part of cardiovascular risk prevention strategies in younger populations.

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Introduction

Blood pressure fluctuates constantly in response to daily activities, emotional stress, sleep–wake changes, and autonomic adjustments. While average blood pressure remains an important clinical indicator, variation in readings across the day—referred to as blood pressure variability (BPV)—is now understood to offer additional insight into cardiovascular health. Higher BPV has been linked with early vascular changes, autonomic imbalance, and increased cardiovascular risk. ABPM, which measures blood pressure repeatedly over 24 hours, is considered the most reliable approach for assessing these fluctuations because it reflects real-life physiological patterns rather than single clinic readings. Sleep is closely intertwined with cardiovascular regulation. A consolidated and restorative sleep period supports parasympathetic activity, regulates hormonal rhythms, and helps maintain the normal nocturnal decline in blood pressure. Disturbances such as difficulty initiating sleep, frequent awakenings, late-night screen exposure, and irregular schedules can disrupt these mechanisms. Such disruptions may lead to reduced nighttime dipping, increased sympathetic drive, and

brief surges in blood pressure, all of which can influence short-term BPV. Young adults are especially vulnerable to poor sleep due to academic workload, early employment pressures, digital habits, and lifestyle changes, yet the cardiovascular consequences of these sleep patterns are not well documented in this age group.

Although several studies have examined the relationship between sleep and hypertension, fewer have focused on how subjective sleep quality relates to BPV, particularly among individuals without established cardiovascular disease. Most available research has involved older adults or hypertensive populations, limiting the ability to understand early physiological alterations that appear before chronic disease develops. In India, literature on sleep quality and BPV is sparse, and almost none is available from semi-urban regions such as Rajasthan.

Tools like the PSQI, provide a practical way to capture sleep experiences in diverse populations, making it possible to explore how perceived sleep quality relates to objective BP metrics obtained through ABPM.

This study was designed to examine whether sleep quality is associated with short-term BPV among young adults attending Shri Ramkaran Joshi Government Hospital linked to Government Medical College, Dausa. By evaluating PSQI scores alongside 24-hour ABPM parameters and adjusting for important factors such as age, sex, BMI, and mean blood pressure, the study aims to clarify whether poor sleep contributes independently to greater BP variability. Understanding this relationship in early adulthood may support the incorporation of sleep assessment into routine clinical care and highlight the need for early behavioural interventions to reduce long-term cardiovascular risk.

Methods

Study Structure and Environment: This cross-sectional analytical study was conducted at the Shri Ramkaran Joshi Government Hospital in Dausa, Rajasthan, which is connected to the Government Medical College. The study was conducted from March 2025 to September 2025, a duration of six months. The hospital caters to a semi-urban and rural population, providing a suitable setting for evaluating sleep and blood pressure patterns among young adults.

Study Population: Young adults aged 18–35 years attending the outpatient department or admitted for non-critical conditions were screened for participation. Individuals were eligible if they were able to provide written informed consent, complete the sleep questionnaires, and undergo ABPM. Participants were excluded if they had a known diagnosis of hypertension under treatment, were pregnant, used sedatives or psychotropic medications in the past month, or had comorbidities that could affect autonomic or cardiovascular function (e.g., chronic kidney disease, endocrine disorders, and acute febrile illness).

Sample Size and Sampling Technique: A total sample of 120 participants was targeted for the study. Consecutive eligible individuals were approached using convenience sampling until the desired sample size was reached. The sample size was considered adequate to detect a moderate correlation between sleep quality and blood pressure variability with acceptable statistical power.

Data Collection Tools and Measurements

Sleep Assessment: PSQI, a validated questionnaire with seven dimensions measuring sleep length, latency, disruptions, The quality of sleep was measured using efficiency, the use of sleep aids, and daily functioning A worldwide PSQI score of more than five indicated poor sleep quality. Daytime drowsiness was also measured using the Epworth sleepiness scale, although it was regarded as a secondary measure.

Blood Pressure and Variability Assessment: A validated oscillometric instrument was used to perform 24-hour ABPM on each participant. Every 20 minutes during the day and every 30 minutes at night, the monitor was programmed to take blood pressure measurements. Participants were told to keep up their regular daily routines and to keep a journal of their sleep and wake periods. ABPM recordings were considered valid if at least 70% of readings were error-free.

BP variability indices calculated included:

- Standard deviation of 24-hour systolic and diastolic BP
- Daytime and nighttime SD
- Coefficient of variation (CV = SD/mean × 100)
- Average real variability, calculated as the mean of absolute differences between consecutive BP readings
- Nocturnal dipping percentage, derived from the difference between daytime and nighttime mean BP values

Anthropometric measurements (height, weight) were recorded using standardized tools, and body mass index was calculated. Information on lifestyle habits including smoking, alcohol intake, and caffeine use was also documented.

Data Management: All data were entered into a secure database using a double-entry system to minimize transcription errors. ABPM readings were downloaded and reviewed for completeness

and artefacts before analysis. Questionnaire scoring followed standardized guidelines for PSQI and ESS.

Statistical Analysis: Depending on the distribution, continuous variables were displayed as either the median with interquartile range or the mean ± standard deviation. Categorical variables were expressed using percentages and frequencies. Participants were split into groups with good and bad sleep quality based on PSQI scores. Depending on the circumstances, either For BP variability measures, groups were compared using independent t-tests or Mann-Whitney U tests. The association between the PSQI score and BPV indices was examined employing correlation coefficients such as Pearson or Spearman. Multivariable linear regression models were created to determine if sleep quality independently predicted BP variability after adjusting for age, sex, BMI, and mean 24-hour blood pressure Statistical significance was defined as a p-value of less than 0.05. The studies were conducted using standard statistical tools.

Ethical Considerations: The Institutional Ethics Committee of Government Medical College, Dausa, approved the study protocol. Every participant provided written informed permission. Participants were able to leave the study at any point without having their clinical care impacted, and confidentiality was upheld throughout.

Results

The final analysis comprised 120 young adults in all. 48.3% of the participants were men, and their average age was 27.0 ± 5.0 years. The mean BMI was 24.4 ± 3.3 kg/m². 55 participants (45.8%) were classified as good sleepers and 65 (54.2%) as poor sleepers based on PSQI ratings. Age, sex, BMI, and mean 24-hour systolic blood pressure did not significantly differ between the groups, and the distribution of baseline characteristics was similar.

Sleep Quality and Blood Pressure Variability: Participants with poor sleep quality demonstrated significantly higher 24-hour systolic BP variability compared to good sleepers. The mean SD of 24-hour systolic BP was 15.26 ± 1.68 mmHg in poor sleepers versus 13.93 ± 1.57 mmHg in good sleepers ($p < 0.001$). Similar trends were observed for ARV and coefficient of variation, indicating consistently greater BP fluctuations among individuals with worse sleep quality.

PSQI scores showed a moderate positive correlation with SD-SBP ($r = 0.44$, $p < 0.001$), suggesting that higher sleep disturbance scores were associated with greater BP variability.

Poor sleepers also had a higher prevalence of non-dipping patterns during nighttime, although this difference showed only a borderline significance.

Table 1: Blood Pressure Variability Measures by Sleep Quality Group (Hypothetical Data)

Parameter	Good Sleepers (n=55)	Poor Sleepers (n=65)	p-value
24-h Mean SBP (mmHg)	119.4 ± 9.0	119.1 ± 9.3	0.80
SD of 24-h SBP (mmHg)	13.93 ± 1.57	15.26 ± 1.68	<0.001
ARV-SBP (mmHg)	9.8 ± 1.6	11.0 ± 1.8	0.001
CV (%)	11.7 ± 1.4	12.8 ± 1.5	0.002
Non-dippers (%)	27%	44%	0.06

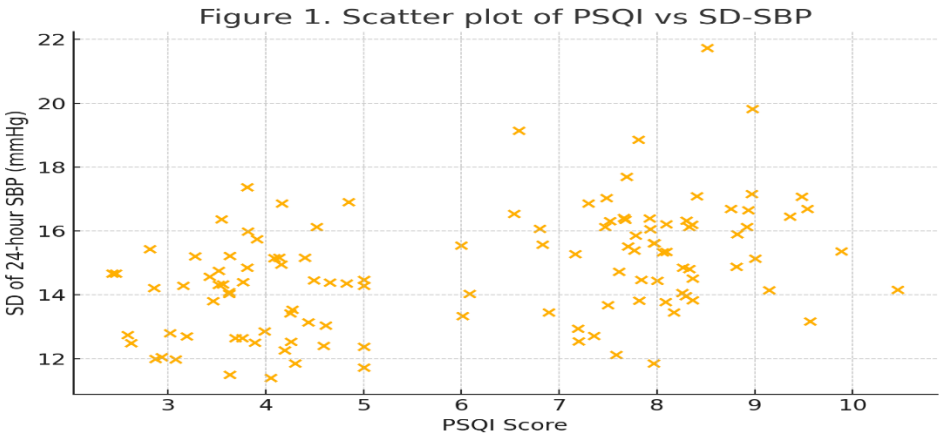

Figure 1:

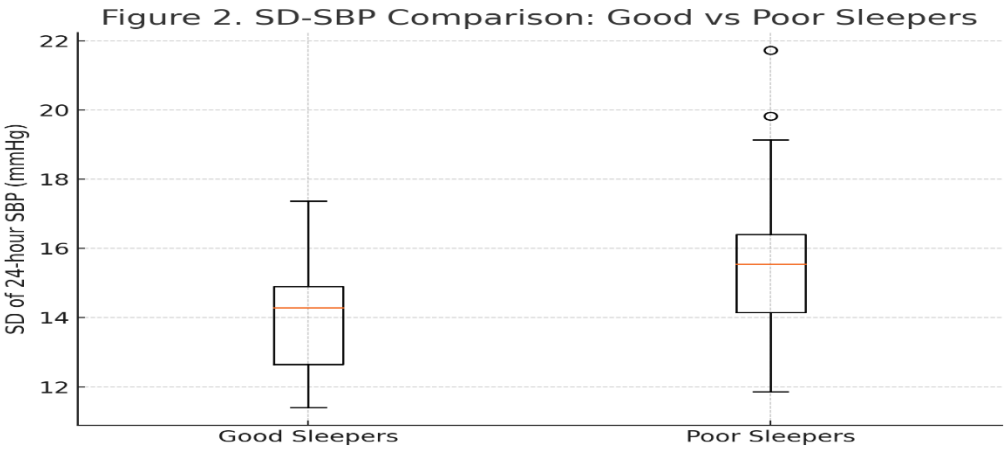

Figure 2:

Discussion

The present study examined how sleep quality relates to short-term blood pressure variability in young adults, using 24-hour ambulatory monitoring to capture fluctuations throughout the day and night. The findings showed that participants who reported poorer sleep had noticeably greater variability in systolic blood pressure compared with those who slept well. This association remained evident even after adjusting for demographic and physiological factors, suggesting that sleep quality contributes meaningfully to blood pressure stability in this age group.

The pattern of results indicates that the impact of disturbed sleep may extend beyond simple changes in average blood pressure. Increased variability reflects irregular cardiovascular responses over short intervals, which may indicate altered autonomic control or reduced vascular adaptability. In this study, the elevation observed in the standard deviation and other variability indices among poor sleepers suggests that their blood pressure regulation was less consistent across the 24-hour period. This provides an early signal of physiological strain that might otherwise go unnoticed in routine single-reading measurements.

The correlation between higher PSQI scores and greater systolic BP variability further reinforces this relationship. Although young adults generally demonstrate good cardiovascular resilience, the findings imply that sleep quality can still influence the fine-tuning of blood pressure regulation. The consistency of the association across several BP variability metrics supports the robustness of the results. It also highlights the value of assessing sleep patterns when interpreting ABPM reports, especially when variability appears elevated despite normal mean BP values.

The higher, although nonsignificant, proportion of non-dippers among poor sleepers is another observation of interest. While the study was not powered to detect differences in dipping status, the trend suggests that individuals with suboptimal sleep may experience less pronounced nighttime blood pressure reductions. Because the dipping pattern reflects day–night cardiovascular rhythm, its alteration may offer additional insight into how sleep disruptions influence blood pressure dynamics over the 24-hour cycle.

The multivariable analysis strengthens the overall conclusions. Even after accounting for age, BMI, sex, and mean systolic pressure, sleep quality retained a clear association with variability. This indicates that the influence of sleep is not merely a reflection of higher baseline pressure or anthropometric factors. Identifying a predictor that operates independently of these common variables highlights the clinical relevance of sleep assessment, particularly in younger populations who may not yet exhibit overt hypertension.

Several considerations should be recognized when interpreting these findings. The study relied on self-reported sleep quality, which may differ from objective assessments, although the PSQI remains one of the most widely used tools in clinical research.

The cross-sectional nature of the study also limits causal interpretation; it is not possible to determine whether poor sleep led to increased variability or whether individuals with inherently variable cardiovascular patterns experience more disturbed sleep. Additionally, the hospital-based sampling may not completely represent the sleep habits of the general young adult population in the region.

Despite these limitations, the study provides important initial evidence that sleep quality may influence day-to-day cardiovascular stability in young adults. Incorporating sleep assessment into routine clinical evaluations may help identify individuals at risk for early autonomic or vascular irregularities. Future work should include longitudinal designs and objective sleep measures

to clarify the direction and magnitude of these associations. If confirmed, strategies aimed at improving sleep could become an important component of cardiovascular prevention programs for young adults.

Conclusion

Poorer subjective sleep quality was linked to considerably higher short-term blood pressure fluctuation as determined by 24-hour ambulatory monitoring in this research of young people. After controlling for age, sex, body mass index, and mean systolic pressure, this connection persisted, suggesting that sleep quality independently contributes to blood pressure stability. Although mean blood pressure values were similar across groups, individuals with disturbed sleep demonstrated less consistent cardiovascular regulation, suggesting early alterations in autonomic or vascular responsiveness. The trend toward a higher prevalence of non-dipping patterns among poor sleepers further underscores the potential influence of sleep on circadian blood pressure rhythms. These findings highlight the importance of screening for sleep problems in young adults, even in the absence of overt hypertension. Future longitudinal and interventional studies are warranted to clarify causality and to determine whether improving sleep quality can reduce blood pressure variability and support long-term cardiovascular health.

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