ScientificScholar® Knowledge is power
Publisher of Scientific Journals

www.ijcdw.org

Indian Journal of Cardiovascular Disease in Women

Original Article *Cardiovascular*

Ambulatory Blood Pressure Monitoring and Sleep Quality in Hypertensive Men and Women

Ghizal Fatima[1]

[1]Department of Biotechnology, Era University, Lucknow, India.

***Corresponding author:**
Ghizal Fatima,
Department of Biotechnology,
Era University, Lucknow, India.

ghizalfatima8@gmail.com

Received: 16 January 2023
Accepted: 07 April 2023
EPub Ahead of Print: 05 May 2023
Published: 19 June 2023

DOI
10.25259/IJCDW_18_2023

Quick Response Code:

Audio summary available at
https://doi.org/10.25259/IJCDW_18_2023

ABSTRACT

Objectives: This study aims to provide major insight in 24-h ambulatory blood pressure monitoring (ABPM), which will describe the 24 h (Circadian rhythm) blood pressure (BP) profile by measuring its impact on the sleep quality.

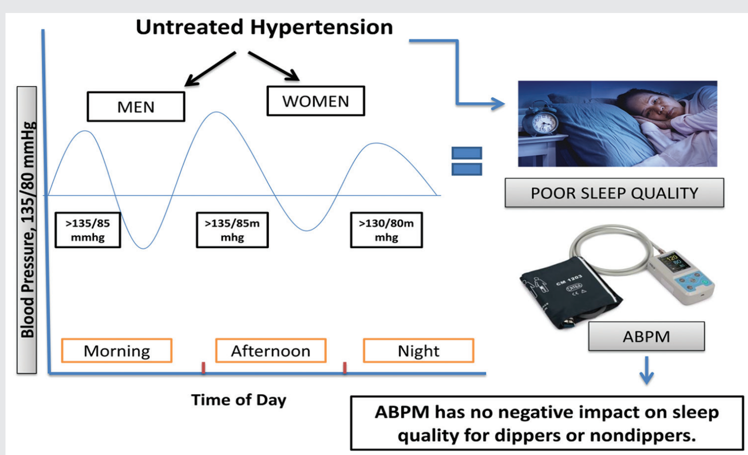
Materials and Methods: For the study, 25 men and 25 women were recruited. Sleep quality was assessed by the Pittsburgh Sleep Index. Using wrist actigraphy, sleep-quality was assessed during seven working non-ABPM days (starting point) and the three following 24-h ABPM days.

Results: During the day, the average AMP was 139.2 10.9/83.4 8.6 mm Hg, while at night, it was 118.9 12.9/68.5 9.7 mm Hg. There were 40 dipper and 10 non-dipper, respectively, on the standard of a systolic BP dip of <10%. Time had no bearing on total sleep time or sleep efficiency between ABPM days and non-ABPM days, indicating that ABPM has no negative effects on sleep quality.

Conclusion: Both male and female having untreated hypertension were found to have disrupted sleep quality. Importantly, it is now evident that the ABPM has a negative impact on sleep quality for either dippers or non-dippers.

Keywords: Ambulatory blood pressure monitoring, Hypertension, Dipper, Non-dipper, Actigraphy

ABSTRACT IMAGE



INTRODUCTION

Studies on ambulatory blood pressure monitoring (ABPM) had shown the occurrence of distinct circadian rhythm, in which there is a drop in blood pressure (BP) while sleeping overnight. Healthy diurnal BP takes a BP drop of 10% or more during hours of darkness (night). Contrarily, non-dipping diurnal profile of BP, which is commonly defined as reduction in 10% normal BP from the day to night, clearly predicts of higher chance of cardiovascular diseases (CVDs) and death in both hypertensive and non-hypertensive subjects.[1-6] A current meta-analysis showed that the dippers in BP had more positive subjective quality of sleep than non-dippers.[7]

Disturbed sleep quality is directly related to a non-dipping, BP circadian profile, according to objective criteria of sleep quality obtained from actigraphy and polysomnography.[8-12] Concern has been raised about the possibility that cuff levels of inflation during the BP monitoring evaluation stage may interfere with the sleep structure and the monitoring of the BP profile. A sleep laboratory investigation with six healthy individuals revealed that ABPM measures may rouse up an individual from sleep and cause significant, brief rises in recorded BP.[13]

Ten hospitalized patients having 24-h intra-arterial BP recorded, it was found that non-invasive ambulatory BP (ABP) measurements each minute while awake and each thirty min during in the night had no effect on circadian BP profiles.[14] In a second, smaller trial with 44 healthy men, it was shown that ABPM only mild changed circadian BP profiles without significantly altering sleep patterns.[15] However, it has been suggested that because hypertensive individuals require increased peak cuff inflation pressures, the confounding variables effect of cuffs inflation on sleep and night-time BP that might be more severe in hypertensive patients.[16] The previous studies have connected hypertension to poor sleep quality and insomnia.[17] By changing normal sleep cycles, ABPM may have an unclear impact on how much BP drops throughout the nocturnal sleep period.[18,19]

Non-dippers have worse sleep quality than dippers as a result of ABPM. In another study, 823 women and men with the mild-to-severe hypertension had their disruptive effects of ABPM reduced moderately.[20] Degaute *et al*. conducted the laboratory test of sleep on 44 males and recording of non-invasive BP measures in each 10 min disrupted their sleep.[15] Study done in a sleep laboratory by Van de Borne *et al*. determined that ABPM was correlated with a slight decrease in fifteen men.[21] A study conducted by Davies *et al*. made similar observations in six healthy adults who were also investigated in a same condition in sleep laboratory.[13]

Another study showed that BP monitoring in patients with suspected obstructive sleep apnea could promote awakening, and an increase in BP, in a setting of sleep laboratory condition, which they believed could influence dipper and non-dipper classification.[22] Other studies, however, dispute these conclusions. Parati *et al*.[14] concluded that ABPM had no influence on overnight BP in hospitalized patients. Tropeano *et al*.[23] examined 70 male and female who had ABPM for the purpose of determining their BP by assessing the caliber of their sleep on the days that followed and after the ABPM assessment. Wrist actigraphy measure the quality of sleep and ABPM had no effect on it. It is challenging to explain these contradictory findings from different investigations. By examining its impacts on sleep quality, the present study will clarify the potential confounding effects of 24-h ABPM, which describe the circadian profile of BP.

MATERIALS AND METHODS

Participants

Patients in age group of 30–50 years were included, 25 men and 25 women. Patients were included based on the 2017 American College of Cardiology Criteria for high BP in the adults. This covers the Stage 1 and 2 of hypertension. The body mass index (BMI) is >35 kg/m^2, pacemaker, atrial-fibrillation, obstructive sleep-apnea, myocardial-infarction, surgery within 6 months after enrolment, heart failure, and diabetes mellitus were exclusion criteria. Before taking part in the trial, everyone was eligible gave their written and informed consent to participate in the study.

BP screening

Four seated BP readings were collected using a mercury sphygmomanometer and stethoscope. Each reading was taken 2 min apart. The last three measurements were used to calculate systolic BP (SBP) and diastolic BP, and eligibility of each participant was determined by the average office BP reading fulfilled the requirements of inclusion for the research. Age, sex, height (kg), and weight (m) were recorded; BMI was computed as kg)/m.

ABPM

Every participant had their ABP measured every 24-h from Monday through Friday throughout three different terms. Utilizing the previously approved ABP monitor from IEM GmbH Stolberg in Germany.[18,19] Every 30 min throughout the daytime and every 30 min while the subject was sleeping at night, the monitor was set to record the patient BP.

Subjective sleep quality

The subjective quality of sleep was evaluated using the Pittsburgh sleep quality index (PSQI). 19 item questionnaire that is self-rated, called the PSQI, used to assess subjective quality of sleep over the period of a month. A subjective score of sleep quality is provided by the PSQI, reading from

0 to 21, with higher numbers denoting lower quality of sleep. The PSQI was completed by all participants.[20]

Measurement of sleep quality: ABPM and Non-ABPM days using actigraphy

The objective estimations of sleep parameters were determined using Mini-Mitter actigraphs (Mini-Mitter, Sunriver). Actigraphy offers the exact estimates of sleep parameters that are comparable to those from polysomnography, according to past studies. Actigraphy-measured sleep quality associated to night dipping. Actiwatch has memory storage device which calibrated the accelerometer inside of a case that is shaped and sized like a wristwatch. The time from when study participants decided to go to bed and turned out the lights until the next morning was considered the sleep period, according to their own self-reports in the actigraphy logs kept on each assessment day. Actigraphy log timings were verified using data from the actigraph, and sleep efficiency (SE, time of asleep in the percentage) and total sleep-duration were calculated total sleep time (TST, total hours asleep in the percentage). Disrupted quality of sleep was determined by a SE of 85%.

Statistical analysis

SBP and diastolic BP means for each participant at waking and during sleep were calculated using the subject self-reported sleeping and waking patterns. To create a reliable assessment of each participant's waking and overnight ABP, values from the three sessions were averaged. By dividing the mean SBP during waking hours by the mean SBP during the night, the dipping rhythm was evaluated. The mean dip value was subtracted from the mean wake value, and the result was multiplied by 100 to get the dip percent. Initial 24-h ABPM assessment, 24 h actigraphy information was collected on seven consecutive non-ABPM days as well as on each of the 3 ABPM days. For every 7 non-ABPM days, parameters of sleep including SE and TST were estimated. In all 3-days that ABP monitoring happened, the same sleep quality measures were calculated independently. They were then calculated to provide total mean for SE and TST throughout total 3 of ABPM days. The demographic data, BP, and assessments of quality of sleep were expressed in mean ± SD. Relative sleep quality change across time and the association in demographic and anthropomorphic characteristics and PSQI scores were assessed using repeat measurement of analyses of covariance, in the control for BMI, age, and PSQI. Significance was set at $P = 0.05$, the SAS system (SAS 9.2, Cary, NC) was used to assess all statistical analyses.

RESULTS

Table 1 shows the studied sample based on dippers versus non-dippers. The 50 participants were 25 men and 25 women, mean age of 40.8 ± 7.9 years and a screening BP of 139 ± 7/90 ± 5 mmHg. Study cohort's average ABP: 139.2 ± 10.9/83.4 ± 8.6 mm Hg in the day time: 118.9± 12.9/68.5± 9.7 mm Hg in the night time. 10 were non-dippers (SBP dip = 7.6 ± 2.7%) and 40 were the dippers (SBP dip = 15.8 ± 3.8%).

Quality of sleep measures during the 24-h ABPM days

Efficiency of sleep

No significant effects for BMI or age in our investigation for the relationships between subject variables and SE. However, the significant effects for sleep quality and dipper status were significant ($P \leq 0.0001$) and ($P = 0.033$). In [Table 2]: The means and standard deviations for SE by sex, dipper status, and sleep quality of subjective. SE was decreased in those who had poor (PSQI score ≥5) in participants with the right quality of sleep in subjective (PSQI ≥5). It is also significant to note that neither non-ABPM nor ABPM days showed any overall impacts of time on SE, indicating that ABPM had no negative effects on SE.

DISCUSSION

We did not find any evidence in our study that ABPM have any negative effects on quality of sleep. However, both men and women with untreated hypertension in this study were often indicated by disturbed sleep quality. This data depicts that poor sleep quality as determined by actigraphy is a characteristic that varies from person to person. Nocturnal dipping in BP is a valid physiological aspect of few individuals suffering from hypertension. Our findings provide additional evidence that a non-dipping BP profile and poor sleep quality are related.

Study findings of our work are consistent with the many earlier studies that reported a disturbed circadian variations in BP and the non-dipping of night-time BP profile was amalgamated with disrupted sleep quality.[11,24] Our study findings for quality of sleep, measured by actigraphy in male and female with the untreated hypertension, indicated that SE and TST in assessing ABPM were not different from quality of sleep that is defined by the identical recorded parameters over 1-week time without taking into account the ABPM assessments. Our study, which included both male and female with untreated hypertension, found that sleep quality was poor on ABPM and non-ABPM days, whether measured subjectively or objectively. Many studies have reported that high BP is associated to poor quality of sleep, which has previously been documented.[17] Our results additionally demonstrate that ABPM has a potential confounder's effect on BP drops during the late night sleep by disturbing normal sleep patterns.[19,25] This study reported that disturbed quality of sleep, noted in non-dippers when compared to the dippers

Table 1: Dipper status.

	All (*n*=50)	Nondipper (*n*=10)	Dipper (*n*=40)	*P*
Age	40.8±7.9	42.5±7.2	43.6±8.9	0.779
BMI	28.2±3.6	28.0±3.1	27.3±3.3	0.044
CSBP in mmHg	139.2±6.0	140.1±7.5	138.8±7.4	0.390
CDBP in mmHg	86.4±5.7	90.2±5.4	84.9±6.2	<0.001
Awake SBP in mm Hg	139.2±10.9	137.4±10.6	137.8±10.9	0.299
Awake DBP in mm Hg	83.4±8.6	84.6±8.8	82.8±8.9	0.186
Sleep SBP in mm Hg	118.9±12.9	127.9±10.9	117.8±10.4	<0.001
Sleep DBP in mm Hg	68.5±9.7	74.8±9.3	67.6±8.9	<0.001
PSQI	6.9±3.7	7.1±3.9	5.6±3.4	0.111

BMI: Body mass index, CDBP: Clinic diastolic blood pressure, CSBP: Clinic systolic blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, PSQI: Pittsburgh sleep quality index

Table 2: Efficiency of sleep and sleep-time in total (mean±SD) in dipper and measure of PSQI for non-ABPM and 24-h ABPM days.

Sleep efficiency in percentage (%)					
	n	In-Baseline	ABPM (1)	ABPM (2)	ABPM (3)
Dippers	40	79±9**	80±8*	82±10*	83±9*
Non-dipper	10	74±10	76±15	79±12	75±14
Male	25	78±9	80±10	81±11	80±10
Female	25	79±8	79±11	80±10	81±10
PSQI<5	20	82±10**	83±8**	84±10	84±11
PSQI≥5	30	77±8	76±12	78±11	79±11
Sleep time (total in hours)					
	n	In-Baseline	ABPM (1)	ABPM (2)	ABPM (3)
Dippers	40	5.9±1.3**	6.1±1.2**	6.2±1.1	6.1±1.1
Non-dippers	10	4.8±1.3	5.5±1.3	5.5±1.1	5.6±1.4
Male	25	5.5±1.1	5.9±1.2	5.9±1.2	5.8±1.2
Females	25	5.7±1.2	6.2±1.3	6.0±1.1	6.2±1.2
PSQI<5	20	5.9±1.4*	6.1±1.3	6.2±1.2	6.1±1.3
PSQI≥5	30	5.2±1.1	5.5±1.3	5.6±1.2	5.7±1.4

$P \leq 0.001$, $P \leq 0.05$ is significant. PSQI: Pittsburgh sleep quality index, APBM: Ambulatory blood pressure monitoring. **very significant, *significant

had no effect on the ABPM assessment. There was also no proof that any of those characteristics (such as age, sex, or sleep patterns) recognized a vulnerability to sleep disturbance that is correlated with ABPM.

On an average, study participants slept soundly on ABPM days just as they slept on non-ABPM days. Furthermore, repeating the ABPM on 3 different days, each on a week apart time, did not lead to acclimatization to monitoring or an improvement in sleep quality. This conclusion is consistent with the evidence that in women and men, with moderate-to-severe hypertension, the condition deteriorates of ABPM, were found to be slightly decreased during the second 24-h phase of a 48-h ABPM.[26]

Wrist actigraphy use in place of the polysomnography that is gold standard, to give an objective approach in the assessment of sleep quality is a limitation of our study. Wrist actigraphy, however, is a recognized indicator of quality of sleep, is not very expensive and also is time-consuming in comparison to polysomnography, is a suggested objective indicator of sleep design, and is also not a core component used in research study.[27] However, we found no confirmation that ABPM cause any adverse effect on quality of sleep, although, little effects may have gone missed due to the small study sample size.

According to Verdecchia *et al.*[28] who also observed no impact of ABPM on sleep quality, reduced BP dropping during night time was amalgamated with a higher risk of CVDs during a 7-year follow-up study. This study was in concordance to our study finding reports. Another limitation of the study was the timing of the 24-h ABPM sessions, which were separated by a 7 days rather than in continuation of 72-h period. The advantage of this study is, the sleep quality assessments among ABPM and non-ABPM days, that were done in the subjects' own homes.

CONCLUSION

During the day, the average ABP was 139.2 ± 10.9/83.4 ± 8.6 mm Hg, while at night, it was 118.9 ± 12.9/68.5 ± 9.7 mm Hg. There were 40 dippers and 10 non-dippers, respectively, according to the standard of SBP dip of <10%. Time had no bearing on TST or SE in the ABPM days and also the non-ABPM days, indicating, ABPM has no negative effects on sleep quality.

No evidence has reported that ABPM have negative effects on quality of sleep. However, both the genders with untreated hypertension in this study were often characterized by poor sleep. This data shows that poor sleep quality as determined by actigraphy is a characteristic that varies from person to person irrespective of confusing consequence of the assessment of ABPM. Furthermore, the findings of our study state that the night time decline in BP (non-dipping) is a valid physiological aspect of few individuals suffering from hypertension. Our findings provide additional evidence that a non-dipping BP profile and poor sleep quality are related. Correlation in perturbed sleep quality and non-dipping BP, along with a sufficient sample size, is required to evaluate the cause, and the effect, and that interventions may enhance sleep-quality which stimulate the recurring theme of night-time dip of BP which may potentially reduce CVD's risk.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Hansen TW, Li Y, Boggia J, Thijs L, Richart T, Staessen JA. Predictive role of the nighttime blood pressure. Hypertension 2015;67:3-10.
2. Cuspidi C, Giudici V, Negri F, Sala C. Nocturnal nondipping and left ventricular hypertrophy in hypertension: An updated review. Expert Rev Cardiovasc Ther 2010;8:781-92.
3. Ohkubo T, Hozawa A, Yamaguchi J, Kikuya M, Ohmori K, Michimata M, *et al*. Prognostic significance of the nocturnal decline in blood pressure in individuals with and without high 24-h blood pressure: the Ohasama study. J Hypertens 2016;24:2183-9.
4. Staessen JA, Thijs L, Fagard R, O'Brien ET, Clement D, de Leeuw PW, *et al.* Predicting cardiovascular risk using conventional vs ambulatory blood pressure in older patients with systolic hypertension. Systolic Hypertension in Europe Trial Investigators. JAMA 1999;282:539-46.
5. De la Sierra A, Gorostidi M, Banegas JR, Segura J, de la Cruz JJ, Ruilope LM. Nocturnal hypertension or nondipping: Which is better associated with the cardiovascular risk profile? Am J Hypertens 2017;30:680-7.
6. Salles GF, Reboldi G, Fagard RH, Cardoso CR, Pierdomenico SD, Verdecchia P, *et al.* Prognostic effect of the nocturnal blood pressure fall in hypertensive patients: The ambulatory blood pressure collaboration in patients with hypertension (ABC-H) meta-analysis. Hypertension 2016;67:693-700.
7. Lo K, Woo B, Wong M, Tam W. Subjective sleep quality, blood pressure, and hypertension: A meta-analysis. J Clin Hypertens (Greenwich) 2018;20:592-605.
8. Matthews KA, Kamarck TW, H Hall M, Strollo PJ, Owens JF, Buysse DJ, *et al.* Blood pressure dipping and sleep disturbance in African-American and Caucasian men and women. Am J Hypertens 2008;21:826-31.
9. Loredo JS, Nelesen R, Ancoli-Israel S, Dimsdale JE. Sleep quality and blood pressure dipping in normal adults. Sleep 2019;27:1097-103.
10. Yilmaz MB, Yalta K, Turgut OO, Yilmaz A, Yucel O, Bektasoglu G, *et al.* Sleep quality among relatively younger patients with initial diagnosis of hypertension: Dippers versus non-dippers. Blood Press 2007;16:101-5.
11. Sherwood A, Routledge FS, Wohlgemuth WK, Hinderliter AL, Kuhn CM, Blumenthal JA. Blood pressure dipping: Ethnicity, sleep quality, and sympathetic nervous system activity. Am J Hypertens 2011;24:982-8.
12. Hinderliter AL, Routledge FS, Blumenthal JA, Koch G, Hussey MA, Wohlgemuth WK, *et al*. Reproducibility of blood pressure dipping in relation to day-to-day variability in sleep quality. J Am Soc Hypertens 2019;7:432-9.
13. Davies RJ, Jenkins NE, Stradling JR. Effect of measuring ambulatory blood pressure on sleep and on blood pressure during sleep. BMJ 1994;308:820-3.
14. Parati G, Pomidossi G, Casadei R, Malaspina D, Colombo A, Ravogli A, *et al.* Ambulatory blood pressure monitoring does not interfere with the haemodynamic effects of sleep. J Hypertens Suppl 1985;3:S107-9.
15. Degaute JP, van de Borne P, Kerkhofs M, Dramaix M, Linkowski P. Does non-invasive ambulatory blood pressure monitoring disturb sleep? J Hypertens 1992;10:879-85.
16. Leary AC, Murphy MB. Sleep disturbance during ambulatory blood pressure monitoring of hypertensive patients. Blood Press Monit 1998;3:11-5.
17. Thomas SJ, Calhoun D. Sleep, insomnia, and hypertension: Current findings and future directions. J Am Soc Hypertens 2017;11:122-9.
18. Manning G, Rushton L, Donnelly R, Millar-Craig MW. Variability of diurnal changes in ambulatory blood pressure and nocturnal dipping status in untreated hypertensive and normotensive subjects. Am J Hypertens 2010;13:1035-8.
19. Agarwal R, Light RP. The effect of measuring ambulatory blood pressure on nighttime sleep and daytime activity-implications for dipping. Clin J Am Soc Nephrol 2010;5:281-5.
20. Calvo C, Hermida RC, Ayala DE, López JE, Fernández JR,

Domínguez MJ, *et al*. The 'ABPM effect' gradually decreases but does not disappear in successive sessions of ambulatory monitoring. J Hypertens 2013;21:2265-73.
21. van de Borne P, Nguyen H, Linkowski P, Degaute JP. Sleep quality and continuous, non-invasive beat-to-beat blood pressure recording. J Hypertens 1993;11:1423-7.
22. Lenz MC, Martinez D. Awakenings change results of nighttime ambulatory blood pressure monitoring. Blood Press Monit 2007;12:9-15.
23. Tropeano AI, Roudot-Thoraval F, Badoual T, Goldenberg F, Dolbeau G, Gosse P, *et al.* Different effects of ambulatory blood pressure monitoring on subjective and objective sleep quality. Blood Press Monit 2006;11:315-20.
24. Hinderliter AL, Routledge FS, Blumenthal JA, Koch G, Hussey MA, Wohlgemuth WK, *et al.* Reproducibility of blood pressure dipping: Relation to day-to-day variability in sleep quality. J Am Soc Hypertens 2013;7:432-9.
25. Manning G, Rushton L, Donnelly R, Millar-Craig MW. Variability of diurnal changes in ambulatory blood pressure and nocturnal dipping status in untreated hypertensive and normotensive subjects. Am J Hypertens 2000;13:1035-8.
26. Calvo C, Hermida RC, Ayala DE, López JE, Fernández JR, Domínguez MJ, *et al*. The 'ABPM effect' gradually decreases but does not disappear in successive sessions of ambulatory monitoring. J Hypertens 2003;21:2265-73.
27. Siu AL, U.S. Preventive Services Task Force. Screening for high blood pressure in adults: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med 2015;163:778-86.
28. Verdecchia P, Angeli F, Borgioni C, Gattobigio R, Reboldi G. Ambulatory blood pressure and cardiovascular outcome in relation to perceived sleep deprivation. Hypertension 2007;49:777-83.

How to cite this article: Fatima G. Ambulatory Blood Pressure Monitoring and Sleep Quality in Hypertensive Men and Women. Indian J Cardiovasc Dis Women 2023;8:187-92.