Journal of Clinical and Nursing Research, 2025, Volume 9, Issue 3
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Ambulatory Blood Pressure Characteristics and Risk Factors for Circadian Rhythm Abnormalities in Elderly Patients with Hypertension

Yaqian Huang*
Department of Cardiology, Yichang Central People's Hospital, The First College of Clinical Medical Science, China Three Gorges University, Yichang 443003, Hubei, China;
Hubei Key Laboratory of Ischemic Cardiovascular Disease, Yichang 443003, HuBei, China;
Hubei Provincial Clinical Research Center for Ischemic Cardiovascular Disease, Yichang 443003, HuBei, China

***Corresponding author:** Yaqian Huang, 13487232634@163.com

Abstract: *Objective:* To analyze the characteristics of ambulatory blood pressure in elderly patients with hypertension and find out the risk factors of abnormal circadian rhythm. *Methods:* According to the circadian rhythm of patients' blood pressure, they were divided into group A, group B, and group C, and all the data of hypertension patients in this study were collected, including age, gender, BMI, smoking, drinking, basic diseases (diabetes, cerebrovascular disease, hyperlipidemia, etc.), fasting blood glucose, ambulatory blood pressure (24-hour mean systolic pressure, 24-hour mean diastolic pressure, daytime mean systolic pressure and daytime mean diastolic pressure). *Results:* There were significant differences in mean systolic blood pressure and mean diastolic blood pressure at night among group A, group B and group C ($P < 0.05$). Age, hyperlipidemia and fasting blood glucose were risk factors for circadian rhythm abnormality ($P < 0.05$), and 24-hour urinary sodium was a protective factor for circadian rhythm abnormality ($P < 0.05$). *Conclusion:* Age, hyperlipidemia and fasting blood glucose are risk factors for circadian rhythm abnormality ($P < 0.05$), and 24-hour urinary sodium is a protective factor for circadian rhythm abnormality ($P < 0.05$).

Keywords: Elderly patients; Hypertension; Ambulatory blood pressure; Abnormal circadian rhythm

Online publication: April 4, 2025

1. Introduction

With China gradually entering an aging society, society is paying more attention to the health status of the elderly and hypertension has become the main risk factor leading to cerebrovascular emergencies and death of the elderly. According to foreign research data, in patients with essential hypertension, the possibility of abnormal circadian rhythm of blood pressure is in the range of 41% to 62% [1, 2]. After Li *et al.* conducted a study on ambulatory

blood pressure monitoring of 106 elderly hypertensive patients, they found that only 21% of them had normal blood pressure rhythm, while 79% had abnormal blood pressure rhythm [3]. Through ambulatory blood pressure monitoring, not only can the blood pressure changes of hypertensive patients be observed throughout the day, but also deeply understand their blood pressure fluctuations and irregular rhythm between day and night. This method is helpful in evaluating the damage of target organs, predicting the potential risks related to cardiovascular and cerebrovascular diseases, and providing immediate and powerful treatment suggestions for clinicians, thus reducing the possibility of hypertension-related complications [4–6]. Therefore, when monitoring the circadian rhythm of blood pressure in elderly hypertensive patients, clinical medical workers must pay high attention to it, which will help to manage the blood pressure level of the elderly population more efficiently, restore their normal rhythm of blood pressure, and further reduce the possibility of cardiovascular events and deaths.

2. Data and methods

2.1. General information

According to the inclusion and exclusion criteria, 272 elderly patients with hypertension who were treated in our hospital from January 2022 to January 2024 were selected, including 126 males, accounting for 46.32%, and 146 females, accounting for 53.68%, aged between 61 and 77, with an average of (68.19 ± 9.23) years. This study has been approved by the Ethics Committee and strictly abides by the ethical principles of medical research and clinical trial regulations.

2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) Patients over 60 years old; (2) Meet the diagnostic criteria of hypertension in the Guidelines for Prevention and Treatment of Hypertension in China (revised edition in 2018) [7]; (3) Patients with complete clinical data; (4) Patients who are willing and able to cooperate with this study.

Exclusion criteria: (1) Patients with liver and kidney dysfunction; (2) Patients participating in other intervention projects; (3) Patients who have a history of lumbar surgery, lumbar tumors, etc., and may have low back pain; (4) Patients with serious diseases such as COPD or malignant tumor; (5) Patients with mental illness or taking psychotropic drugs.

2.3. Methods

There are no patients with dipper in this study, so this study is divided into group A, group B, and group C according to the circadian rhythm of patients' blood pressure. Group A is dipper (the blood pressure decreased by more than 10% at night compared with that during the day), group B is non-dipper (the blood pressure decreased by less than 10% at night compared with that during the day) and group C is inverse dipper (the blood pressure decreased by less than 10% during the day). All the data of hypertension patients in this study were collected, including age, gender, BMI, smoking, drinking, basic diseases (diabetes, cerebrovascular diseases, hyperlipidemia, etc.), fasting blood glucose, ambulatory blood pressure (24-hour mean systolic blood pressure, 24-hour mean diastolic blood pressure, daytime mean systolic blood pressure, daytime mean diastolic blood pressure, nighttime mean systolic blood pressure, nighttime mean diastolic blood pressure), 24-hour urine electrolyte, and blood pressure.

2.4. Statistical methods

All the collected values are entered into SPSS25.0 software for statistical analysis. The counting data are recorded in the form of examples and percentages, and analyzed by χ2 test, and the measuring data are recorded in the form of mean and standard deviation. The data are analyzed by T-test, univariate and multivariate analysis, and there is a difference in statistical level with $P < 0.05$.

3. Results

3.1. Comparison of general data of patients in different groups

Among the patients who participated in this study, there were significant differences in age, sex, BMI, smoking, hyperlipidemia, and fasting blood sugar among group A, group B, and group C ($P < 0.05$). The data is shown in **Table 1**.

Table 1. Comparison of general data of patients in different groups

Variable	Group	Group A (n = 57)	Group B (n = 124)	Group C (n = 91)	F/X^2	P
Age		63.18 ± 8.24	70.27 ± 8.11*	71.13 ± 8.97*	5.144	0.000*
Gender	man	34 (59.65%)	51 (41.13%) *	41 (45.05%) *	5.377	0.020*
	woman	23 (40.35%)	73 (58.87%)	50 (54.95%)		
BMI		24.23 ± 3.12	25.69 ± 3.73	25.72 ± 3.11	2.463	0.015*
Smoke	yes	5 (8.77%)	46 (37.10%) *	41 (45.05%) *	15.481	0.000*
	no	52 (91.23%)	78 (62.90%)	50 (54.95%)		
Drink Wine/alcohol	yes	11 (19.30%)	23 (18.55%)	14 (15.38%)	0.369	0.544
	no	46 (80.70%)	101 (81.45%)	77 (84.62%)		
Combined with basic diseases						
Diabetes	yes	9 (15.79%)	21 (16.94%)	12 (13.19%)	1.152	0.283
	no	48 (83.21%)	103 (83.06%)	79 (86.81%)		
Cerebrovascular disease	yes	7 (12.28%)	19 (15.33)	12 (13.19%)	0.294	0.588
	no	50 (87.72%)	105 (84.68%)	79 (86.81%)		
Hyperlipoidemia	yes	32 (56.14%)	49 (39.52%) *	19 (20.88%) *	4.365	0.037*
	no	25 (43.86%)	75 (60.48%)	72 (79.12%)		
Fasting Blood-glucose		5.61 ± 1.73	6.83 ± 2.81*	6.52 ± 2.33*	2.945	0.004*

Note: * Compared with Group A, there is a significant difference (P < 0.05).

3.2. Comparison of ambulatory blood pressure in different groups of patients

Among the patients who participated in this study, there were significant differences in mean systolic blood pressure and mean diastolic blood pressure at night among group A, group B and group C ($P < 0.05$), but there were no significant differences in mean systolic blood pressure at 24 hours, mean diastolic blood pressure at 24 hours, mean systolic blood pressure at day and mean diastolic blood pressure at day ($P > 0.05$). The results are shown in **Table 2**.

Table 2. Comparison of ambulatory blood pressure in different groups of patients

	Group A (n = 57)	Group B (n = 124)	Group C (n = 91)	*F*	*P*
24-hour mean systolic pressure (mmHg)	131.27 ± 9.23	134.19 ± 12.31	135.24±11.21	1.539	0.126
24-hour mean diastolic blood pressure (mmHg)	71.28 ± 8.13	73.37 ± 9.21	72.33 ± 7.83	1.404	0.162
Daytime mean systolic blood pressure (mmHg)	136.38 ± 9.11	135.72 ± 6.29	132.13 ± 9.06	0.521	0.603
Daytime mean diastolic blood pressure (mmHg)	74.13 ± 6.22	75.43 ± 8.22	72.53 ± 7.11	1.024	0.308
Mean systolic blood pressure at night (mmHg)	118.62 ± 9.11	131.58 ± 10.27	140.82 ± 12.33	7.796	0.000*
Mean diastolic blood pressure at night (mmHg)	62.33 ± 5.81	71.59 ± 6.43	71.29 ± 8.08	8.843	0.000*

Note: * is significantly different from group A ($P < 0.05$), # is significantly different from group B ($P < 0.05$).

3.3. Comparison of 24-hour urinary electrolytes and microalbuminuria in different groups of patients

Based on **Table 3**, among the patients who participated in this study, there were significant differences in 24-hour urinary sodium and microalbuminuria among group A, group B and group C ($P < 0.05$), but there were no significant differences in 24-hour urinary potassium and 24-hour urinary chloride ($P > 0.05$).

Table 3. Comparison of 24-hour urinary electrolytes and urinary microalbumin in different groups of patients

	Group A (n = 57)	Group B (n = 124)	Group C (n = 91)	*F*	*P*
24-hour urine potassium (mmol/24h)	24.51 ± 7.23	25.63 ± 6.21	23.46 ± 6.22	1.002	0.318
24-hour urinary chloride (mmol/24h)	71.38 ± 10.37	73.28 ± 11.28	69.34 ± 12.52	1.028	0.306
24-hour urinary sodium (mmol/24h)	103.27 ± 10.12	87.42 ± 9.15*	83.29 ± 9.11*	9.842	0.000*
24-hour urinary microalbumin (mg/24h)	42.79 ± 9.27	43.18 ± 8.01	49.72 ± 8.22*	4.750	0.000*

Note: * is significantly different from group A ($P < 0.05$), # is significantly different from group B ($P < 0.05$).

3.4. Analysis of risk factors for patients with abnormal circadian rhythm

Taking the patients circadian rhythm abnormality as the dependent variable, and taking age, sex, hyperlipidemia, fasting blood glucose, BMI, smoking or not, 24-hour urinary sodium, and 24-hour urinary microalbumin as the independent variables, the results showed that age, hyperlipidemia, and fasting blood glucose were the risk factors for the patient's circadian rhythm abnormality ($P < 0.05$), and 24-hour urinary sodium was the protective factor for the patient's circadian rhythm abnormality ($P < 0.05$). The results are shown in **Table 4**.

Table 4. Analysis of risk factors of abnormal circadian rhythm in patients

	β	SE	Wald χ^2	P	OR	95%CI
Age	1.928	0.832	6.318	0.029	1.534	1.217–2.484
Gender	0.681	0.448	3.022	0.087	2.068	0.265–9.264
Hyperlipemia	0.013	0.468	4.152	0.043	1.132	1.096–1.472
Fasting blood-glucose	1.525	1.211	7.969	0.024	2.332	1.142–3.225
Smoke	0.922	0.561	3.155	0.075	1.255	0.361–10.642
BMI	1.021	0.395	2.569	0.111	1.258	0.148–4.291
24-hour urinary sodium	-0.581	0.247	10.222	0.001	4.936	2.163–9.358
24-hour urinary microalbumin	0.922	0.561	3.155	0.075	1.255	0.361–10.642

4. Discussion

In the past 20 years, a large number of clinical studies have proved that ambulatory blood pressure monitoring is closely related to the incidence and severity of cardiovascular diseases [8, 9]. Using ambulatory blood pressure monitoring technology, the clinic can more objectively understand the actual level and fluctuation of blood pressure within 24 hours, and this monitoring method is less interfered by the outside world and shows excellent repeatability. For patients with hypertension, the core of treatment is not only to restore their blood pressure to normal level but also to clarify the specific types of their blood pressure rhythm. When carrying out treatment, ensure that blood pressure is maintained in normal rhythm and avoid using drugs that may cause abnormal rhythm.

As people age, the functions of many endocrine glands and vital organs begin to decline, and the sleep-wake cycle also undergoes changes. This disruption affects autonomic nervous system activity, particularly the reduced sensitivity of pressure receptors and decreased vagus nerve activity. These changes lead to dysfunction of the hypothalamic-pituitary-adrenal axis, weakening its ability to regulate blood pressure. Consequently, this results in the loss of the natural circadian rhythm of blood pressure regulation [10-13].

Studies have pointed out that there is a certain correlation between abnormal rhythm of blood pressure and diabetes [14, 15]. Once the cardiac autonomic nervous system of diabetic patients is abnormal, their blood pressure circulation will be gradually interrupted day and night. Its most remarkable feature is that the blood pressure fluctuates at a relatively high level all day, with no obvious peak or valley changes, and the blood pressure does not drop significantly at night. This situation may be caused by the damage of autonomic nervous system function and the imbalance of neurohumoral regulation in diabetic patients, which leads to the increase of peripheral vascular resistance, which is similar to the results of this study [16, 17].

Previous studies have found that in the elderly hypertensive patients with dyslipidemia, blood pressure increased significantly at night, which means that the normal blood pressure circadian rhythm of elderly hypertensive patients with dyslipidemia has disappeared [18, 19]. The increase of blood lipid level may damage the normal function of vascular endothelium and gradually lead to atherosclerosis. This change will reduce the elasticity of the artery, weaken the buffering effect of pulse pressure, increase pulse pressure, and eventually lead to the disappearance of the circadian rhythm of normal blood pressure.

There are still different views in academic circles on how sodium in urine affects the fluctuation of blood pressure between day and night within 24 hours. When there is a problem with the regulation function of sodium, it may lead to the accumulation of sodium, which may further lead to the continuous increase of arterial blood pressure. It may be that the discharge pattern of sodium during the day and night is disrupted and the decrease of sodium in urine during the day is closely related to the increase of blood pressure at night [20].

5. Conclusion

Age, hyperlipidemia, and fasting blood glucose are the risk factors of circadian rhythm abnormality ($P < 0.05$), and 24-hour urinary sodium is the protective factor of circadian rhythm abnormality ($P < 0.05$).

Disclosure statement

The author declares no conflict of interest.

References

[1] Kim BK, Lim YH, Lee HT, et al., 2011, Non-dipper Pattern is a Determinant of the Inappropriateness of Left Ventricular Mass in Essential Hypertensive Patients. Korean Circulation Journal, 41(4): 191–197.

[2] Eleni K, Efstathios M, Vassilios R, et al., 2011, Dipping Status and Hostility in Newly Diagnosed Essential Hypertension. The International Journal of Psychiatry in Medicine, 42(2): 181–194.

[3] Li B, Lai C, Qi L, 2008, Circadian Rhythm Characteristics and Clinical Significance of Blood Pressure in Elderly Patients with Hypertension. Sichuan Medical Journal, 29(1): 50–51.

[4] Yang K, Zhu X, Feng Y, et al., 2020, Abnormal Blood Pressure Circadian Rhythms Are Relevant to Cerebral Infarction and Leukoaraiosis in Hypertensive Patients. BMC Neurol, 20(1): 36. DOI: 10.1186/s12883-020-1626-6.

[5] Takahiro K, Satoshi H, Yuda T, et al., 2023, Cognitive Impairment in Heart Failure Patients: Association with Abnormal Circadian Blood Pressure Rhythm: A Review from the HOPE Asia Network. Hypertension Research: Official Journal of the Japanese Society of Hypertension, 47(2): 261–270.

[6] Velarie BA, LK K, 2023, Associations between Circadian Disruption and Cardiometabolic Disease Risk: A Review. Obesity (Silver Spring, Md.), 31(3): 615–624.

[7] China Hypertension Prevention and Control Guidelines Revision Committee, Hypertension Union (China), Cardiovascular Branch of Chinese Medical Association, et al., 2019, China Hypertension Prevention and Control Guidelines (Revised in 2018). Chinese Journal of Cardiovascular Medicine, 24(1): 24–56.

[8] Tanner MR, Jaeger CB, Bradley KC, et al., 2024, Blood Pressure on Ambulatory Monitoring and Risk for Cardiovascular Disease and All-cause Mortality: Ecological Validity or Measurement Reliability? American Journal of Hypertension, 38(2): 111–119.

[9] El N J, GT B, Jordana C, et al., 2023, Prognostic Utility of Rhythmic Components in 24-hour Ambulatory Blood Pressure Monitoring for the Risk Stratification of Chronic Kidney Disease Patients with Cardiovascular Co-morbidity. medRxiv: The Preprint Server for Health Sciences, 2023.

[10] Yancui S, Ying Z, Fei L, et al., 2023, The Relationship between Circadian Rhythm of Blood Pressure and Vascular Dysfunction in Essential Hypertension. Clinical and Experimental Hypertension (New York, N.Y.: 1993), 45(1): 2229535–2229535.

[11] Kim Y, Kim J, Joh IR, et al., 2024, Disrupted Rest-Activity Circadian Rhythms Are Associated with All-cause Mortality in Patients with Chronic Kidney Diseases. Chronobiology International, 41(11): 11–12.

[12] Line P, MK M, Ulla F, et al., 2021, Brain Tumours in Children and Adolescents May Affect the Circadian Rhythm and Quality of Life. Acta Paediatrica (Oslo, Norway: 1992), 110(12): 3376–3386.

[13] Poppy N, Elizabeth JG, Ed GR, et al., 2021, Changes in Circadian Rhythms Dysregulate Inflammation in Ageing: Focus on Leukocyte Trafficking. Frontiers in Immunology, 12: 673405–673405.

[14] Koren D, Knutson LK, Burke KB, et al., 2024, The Association of Self-Reported Sleep and Circadian Measures with Glycemic Control and Diabetes Complications among Young Adults with Type 2 Diabetes. American Journal of Physiology. Heart and Circulatory Physiology, 326(6): H1386-H1395.

[15] Roberto FSDJ, José FVA, Douglas SDCI, et al., 2023, Non-dipping Circadian Pattern as a Predictor of Incipient Nephropathy in Normotensive Normoalbuminuric Type 1 Diabetics. Chronobiology International, 40(12): 1–6.

[16] Pablo S, Sreenivas K, Arvind S, et al., 2021, Common Genetic Variation in Circadian Clock Genes Are Associated with Cardiovascular Risk Factors in an African American and Hispanic/Latino Cohort. IJC Heart & Vasculature, 34: 100808.

[17] Álvarez-Rendón PJ, Riesgo-Escovar RJ, 2020, Circadian and Rhythmic-related Behavioral Co-morbidities of the

Diabetic State in Drosophila melanogaster. General and Comparative Endocrinology, 295: 113477.

[18] Agostino A, Giulia S, Milos A, et al., 2021, Influence of Smoking and Other Cardiovascular Risk Factors on Heart Rate Circadian Rhythm in Normotensive and Hypertensive Subjects. PloS One, 16(9): e0257660.

[19] Felix LA G, Sousa DA D, Teixeira PS, et al., 2020, Eating Habits, Sleep, and a Proxy for Circadian Disruption Are Correlated with Dyslipidemia in Overweight Night Workers. Nutrition (Burbank, Los Angeles County, Calif.), 83: 111084.

[20] Ferrell MJ, Chiang YJ, 2015, Circadian Rhythms in Liver Metabolism and Disease. Acta Pharmaceutica Sinica B, 5(2): 113–122.