NON-DIPPING BLOOD PRESSURE PATTERNS AND ASSOCIATED TARGET ORGAN DAMAGE IN ELDERLY HYPERTENSIVE PATIENTS

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ABSTRACT

Background: Older adults with hypertension face an increased risk of adverse cardiovascular outcomes, emphasizing the importance of target organ damage (TOD) in their treatment. The non-dipping blood pressure (BP) pattern, characterized by inadequate reduction of nocturnal BP (less than 10-20%), is associated with a higher likelihood of TOD in individuals with essential hypertension. This study aimed to examine the characteristics of non-dipping BP patterns among elderly individuals with essential hypertension and evaluate their associations with TOD. **Methods:** A descriptive cross-sectional study was conducted, involving 96 patients aged ≥60 years (mean age 70.9 ± 7.9 years, 35.4% male). Participants underwent routine clinical and laboratory assessments, including clinic and 24-hour ambulatory blood pressure monitoring. TOD was defined as the presence of left ventricular (LV) hypertrophy, renal impairment, or proteinuria. **Results:** Non-dipping patterns for systolic and diastolic BP were observed in 36 (36.5%) and 41 (42.7%) patients, respectively. TOD was present in 61 (63.5%) patients. Non-dipping systolic patients exhibited lower rates of diabetes mellitus (37.1% vs. 81.3%, p=0.006), dyslipidemia (68.6% vs. 100%, p=0.011), higher levels of creatinine (median 85.6, interquartile range [IQR] 72.1-101 vs. 70.8, IQR 62.4-78.3 µmol/l, p=0.012), and higher LV mass index (median 106.6, IQR 96.4-148.4 vs. 93.7, IQR 72.9-111.5 g/m2, p=0.028) compared to dipping patients. Non-dipping diastolic patients had a lower prevalence of dyslipidemia (73.2% vs. 100%, p=0.048) and a lower body mass index (median 23, IQR 19.73-25 vs. 25.26, IQR 22.54-27.17 kg/m2, p=0.013). Multivariate analysis, after adjusting for cardiovascular risk, showed that non-dipping patterns (both systolic and diastolic) were associated with TOD (odds ratio 7.21; 95% confidence interval 1.47-35.36, p=0.015). **Conclusion**. Our study underscores the significant association between non-dipping blood pressure patterns and TOD in elderly individuals with essential hypertension. The notable prevalence of non-dipping patterns emphasizes the clinical importance of monitoring and managing these patterns in clinical practice.

Keywords: *ambulatory blood pressure monitoring, blood pressure patterns, dipper, elderly, hypertension, non-dipper, target organ damage.*

I. INTRODUCTION

Hypertension is a common cardiovascular condition, particularly prevalent among older adults, and is associated with an increased risk of adverse cardiovascular outcomes [1]. Apart from the well-known risk factors including age, gender, family history of cardiovascular disease, smoking, obesity, dyslipidemia, and diabetes mellitus, the presence of subclinical target organ damage (TOD) such as left ventricular (LV) hypertrophy and renal impairment holds significant importance in the management of individuals with hypertension and the prevention of cardiovascular disease. [2, 3]. Among the various patterns of blood pressure (BP) fluctuations, the non-dipping pattern has emerged as a significant predictor of

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TOD in individuals with essential hypertension [4]. The non-dipping pattern is characterized by inadequate reduction of nocturnal BP, typically defined as less than a 10-20% decrease compared to daytime BP [5]. Understanding the characteristics and associated factors of non-dipping patterns can provide valuable insights into the assessment and management of hypertensive patients. Limited research has been conducted on this topic in Vietnam. Therefore, the purpose of this study is to (1) examine the frequency and characteristics of non-dipping blood pressure (BP) patterns in elderly individuals with essential hypertension and (2) explore their relationship with TOD.

II. PATIENTS AND METHODS

2.1. Study Setting and design

This is a descriptive cross-sectional single-center study, conducting in the Department of Internal Medicine of the Becamex International Hospital (Binh Duong province, Vietnam) from June 2020 to June 2021.

2.2. Patients

This study involved patients aged ≥60 years with a documented diagnosis of essential hypertension, regardless of office BP, under treatment with ≥1 antihypertensive drug stable for ≥1 months.

2.3. Methods

The diagnosis and management of hypertension in this study adhered to the guidelines set forth by the Vietnamese Heart Association and the Vietnamese Society of Hypertension [6], which are in line with the recommendations of the European Society of Hypertension/European Society of Cardiology [12]. Hypertension was diagnosed when systolic blood pressure (SBP) was ≥140 mmHg and/or diastolic blood pressure (DBP) was ≥90 mmHg on at least two separate measurements, or when a history of previously diagnosed and treated hypertension was present [7]. Exclusion criteria were implemented to ensure appropriate participant selection, excluding those with secondary hypertension, individuals under the age of 60 with hypertension, untreated hypertensive patients, those with acute illnesses or severe electrolyte disturbances, participants with less than 85% of the total ambulatory blood pressure monitoring (ABPM) measurement time, and individuals who did not provide consent for the study.

Data collection. The study database captured a wide range of clinical and demographic characteristics, including medical history, as well as laboratory and instrumental data. Body mass Index (BMI) was determined by dividing weight (in kilograms) by the square of height (in meters). Participants were categorized into four BMI groups based on the established criteria for Asian populations: underweight (<18.5 kg/m²), normal weight (18.5-22.9 kg/m²), overweight (23.0-24.9 kg/m²), and obese (≥25 kg/m²) [8].

Physical activity was evaluated using a structured questionnaire administered by a trained assistant. Regular exercise was defined as engaging in physical activity for at least 30 minutes, three times or more per week. Individuals with low physical activity levels did not exercise or had irregular exercise habits (less than three times per week). Smoking status was categorized as current smokers or non-smokers, which included individuals who had never smoked or had quit smoking for at least five years. Diabetes mellitus was diagnosed based on

current use of insulin or hypoglycemic agents, or adherence to the criteria set by the American Diabetes Association in 2020 [9]. Dyslipidemia was defined using thresholds for total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides, or a combination of these criteria, as outlined by the American Heart Association [10]. Dipstick urinalysis was conducted using morning urine samples obtained after overnight fasting. Proteinuria was assessed by interpreting the results based on a color scale categorizing proteinuria as "negative", "trace (±)","1+","2+",'3+",' or "4+". In this study, the dipstick proteinuria results were grouped into three categories: "no proteinuria (-)"," trace (±)", and "overt proteinuria (≥1+)".

The echocardiographic examinations were conducted in the morning, adhering to the guidelines recommended by the American Society of Echocardiography [11]. The left ventricular mass (LVM) was calculated using the formula: LVM (g) = 0.8 x [1.04 x (LVDd + IVSd + PWd)^3 - LVDd^3] + 0.6, where LVDd represents the LV end-diastolic internal dimension, IVSd indicates the end-diastolic thickness of the interventricular septum, and PWd represents the end-diastolic thickness of the LV posterior wall [11]. The left ventricular mass index (LVMI) was obtained by dividing the LVM by the individual's body surface area in square meters. Left ventricular hypertrophy (LVH) was defined as an LVMI exceeding 95 g/m^2 in women and 115 g/m^2 in men [11]. The LV ejection fraction (LVEF) was estimated using the Simpson method, which calculates the percentage reduction in left ventricular volume from end-diastole to end-systole.

All patients underwent 24-hour ambulatory blood pressure monitoring (ABPM) immediately after recording their office blood pressure (BP). The Oscar2 device (SunTech Medical Inc, Morrisville, NC, USA) was used for measurements, and the ABPM data was analyzed using the AccuWinpro v3.4 software package. BP readings were taken at 30-minute intervals from 07:00 to 22:00 hours, and at 60-minute intervals from 22:00 to 07:00 hours, following the ABPM criteria outlined in the European Society of Hypertension guidelines [12]. To ensure accurate data, participants were provided with a diary to record their sleep and wake times, and were advised to avoid vigorous physical activities on the day of the test. A valid record was defined as having at least 85% of valid measurement readings, excluding any abnormal or noisy measurements. Ambulatory BP readings below 70 mmHg or above 260 mmHg for systolic BP, and below 40mmHg or above 150mmHg for diastolic BP were excluded from analysis.

Definition of circadian patterns. The nocturnal decline in blood pressure (BP) and circadian patterns were assessed by calculating the percentage reduction in both systolic BP (SBP) and diastolic BP (DBP) during the night using the following formula: (daytime BP - nighttime BP)/daytime BP [12]. A normal dipping pattern, referred to as a "dipper," was identified when the average SBP reduction during the night exceeded 10% of the mean daytime SBP. If this reduction surpassed 20%, the patient was classified as an "extreme dipper." An abnormal dipping pattern, known as a "non-dipper," was diagnosed when the average SBP reduction during the night was less than 10% compared to daytime values. The patient was classified as a "riser" when the mean nighttime SBP exceeded the daytime SBP [12].

Definition of target organ damage. TOD was defined as a combination of LVH, renal impairment and/or presence of proteinuria. Renal impairment was defined as plasma creatinine levels ≥ 1.3 mg/dl or µmol/l.

The study protocol was reviewed and approved by the Ethics Committee of the Becamex International Hospital and Hue University of Medicine and Pharmacy (Ethics No H2020/346). All patients provided written informed consent.

Statistical Analysis. The collected data were analyzed using SPSS software, version 25. Normally distributed continuous variables were reported as mean ± standard deviation (M±SD), while categorical variables were presented as absolute numbers (percentages): n (%). Non-normally distributed continuous variables were described as median (Me) with interquartile range (IQR). Student's t-test was used for normally distributed continuous variables, and the Wilcoxon rank-sum test (Mann-Whitney U test) was applied for non-normally distributed continuous variables. The chi-squared test or Fisher exact test was used for categorical variables. Logistic regression analysis with backward stepwise approach was used to identify variables associated with TOD. All statistical tests were two-sided, and statistical significance was determined at $p < 0.05$.

III. RESULTS

3.1. Baseline patient characteristics

The study included a total of 96 patients, with a mean age of 70.9 ± 7.9 years and a male representation of 35.4% (Table 1). The majority of hypertension cases (43.8%) were detected within 1-5 years. The proportion of newly diagnosed hypertension patients (<1 year) accounted for 15.6%. Mean BMI was 23.44±3.29 kg/m2. Prevalent cardiovascular risk factors among the participants were dyslipidemia (80.2%), diabetes mellitus (51%), smoking (24%), and history of stroke (11.5%). Family history of hypertension was reported by 54.2% of the participants. Obesity was observed in one-third of patients. Headache and dizziness were reported by more than half of the patients, whereas blurred vision and chest discomfort were reported in 42.7% and 37.5%, respectively. Office SBP and DBP were 150.16±26.06 and 81.46±11.79 mm Hg, respectively.

Table 1. ***The general characteristics of patients included***

Variable	Total (n=96)
Age, years, M±SD	70.9 ± 7.9
Duration of HTN, n %	
• < 1 year	15 (15.6)
• 1-5 years	42 (43.8)
• 6-10 years	21 (21.9)
• >10 years	18 (18.8)
BMI, kg/m^2, M±SD	23.44±3.29
Diabetes mellitus, n (%)	49 (51)
Smoking, n (%)	23 (24)
Dyslipidemia, n (%)	77 (80.2)
Family history of hypertension, n (%)	52 (54.2)
Low physical activity levels, n (%)	67 (69.8)

Variable	Total (n=96)
History of stroke, n (%)	11 (11.5)
Obesity status, n (%)	
• Underweight	7 (7.3)
• Normal weight	35 (36.5)
• Overweight	26 (27.1)
• Obesity	28 (29.2)
Waist circumference, cm, M±SD	93.52±12.25
Central obesity, n (%)	
Headache, n (%)	55 (57.3)
Dizziness, n (%)	61 (63.5)
Blurred vision, n (%)	41 (42.7)
Chest discomfort, n (%)	36 (37.5)
Clinic SBP, mm Hg, M±SD	150.16±26.06
Clinic DBP, mm Hg, M±SD	81.46±11.79

3.2. Parameters of 24-hour ambulatory blood pressure

Table 2 shows ambulatory BP findings in men and women separately, and in the total population. Mean 24-hour SBP and DBP were 130.80 ± 17.43 mmHg and 73.73 ± 10.17 mmHg, respectively. Men had significantly higher mean values of 24-hour, daytime and nighttime SBP. There were not differences between men and women regarding to mean 24-hour, daytime and nighttime DBP.

Table 2. ***Parameters of 24-hour ambulatory blood pressure findings of study participants***

Variable	Total (n=96)	Men (n=34)	Women (n=62)	P
24-hour mean				
• Systolic BP, M±SD, mm Hg	130.80±17.43	135.44±13.55	128.26±18.85	**0.034**
• Diastolic BP, M±SD, mm Hg	73.73±10.17	75.09±9.00	72.98±10.75	0.328
Daytime mean				
• Systolic BP, M±SD, mm Hg	131.10±17.52	135.44±13.69	128.73±18.99	**0.049**
• Diastolic BP, M±SD, mm Hg	73.76±10.39	74.88±9.09	73.15±11.06	0.436
Nighttime mean				
• Systolic BP, M±SD, mm Hg	128.76±19.77	135.06±15.43	125.31±21.12	**0.02**
• Diastolic BP, M±SD, mm Hg	73.24±10.93	75.00±8.98	72.27±11.81	0.244

3.3. Prevalence of different circadian blood pressure patterns in in elderly hypertensive patients

The distribution of blood pressure patterns based on SBP was as follows: 16 patients (16.7%) exhibited a dipping pattern, 35 patients (36.5%) had a non-dipping pattern, and 45 patients (46.9%) showed a rising pattern. When considering DBP, 14 patients (14.6%) displayed a dipping pattern, 41 patients (42.7%) had a non-dipping pattern, and 41 patients (42.7%) showed a rising pattern. Among the patients, 13 (13.5%) had both systolic and diastolic BP dipping, while 32 (33.3%) exhibited an increase in BP during nighttime. A total of 51 (53.1%) patients had non-dipping systolic and/or diastolic BP patterns. Notably, no extreme dipping was observed in any of the patients.

Table 3. ***Prevalence of different circadian blood pressure patterns in elderly hypertensive patients***

Variables	n	%
Systolic blood pressure		
• Nocturnal dipping	16	16.7
• Nocturnal non-dipping	35	36.5
• Nocturnal riser	45	46.5
Diastolic blood pressure		
• Nocturnal dipping	14	14.6
• Nocturnal non-dipping	41	42.7
• Nocturnal riser	41	42.7
Systolic and Diastolic blood pressure		
• Nocturnal dipping	13	13.5
• Nocturnal riser	32	33.3
Systolic and/or Diastolic blood pressure		
• Nocturnal non-dipping	51	53.1

3.4. Characteristics of non-dipping pattern

Non-dipping systolic patients showed lower rates of diabetes mellitus (37.1% vs. 81.3%, p=0.006) and dyslipidemia (68.6% vs. 100%, p=0.011) compared to dipping patients. Non-dipping systolic patients also had higher levels of creatinine (median 85.6, IQR 72.1-101 vs. 70.8, IQR 62.4-78.3 µmol/l, p=0.012), LVM (median 165.5, IQR 139.6-209.9 vs. 142.6, IQR 117.7-165.6g, p=0.049), and LVMI (median 106.6, IQR 96.4-148.4 vs. 93.7, IQR 72.9-111.5 g/m2, p=0.028).

Non-dipping diastolic patients had a lower prevalence of dyslipidemia (73.2% vs. 100%, p=0.048) and a lower BMI (median 23, IQR 19.73-25 vs. 25.26, IQR 22.54-27.17 kg/m^2, p=0.013). No significant differences were found in age, smoking, history of stroke, obesity status, waist circumference, clinic systolic and diastolic BP, eGFR, total cholesterol, triglycerides, HDL, LDL, glucose, uric acid, LV hypertrophy, or LVEF.

The non-dipping group exhibited higher 24-hour and daytime systolic BP compared to the dipper group. Similarly, the non-dipping group had higher 24-hour and daytime diastolic BP compared to the dipper group. Additionally, the non-dipping group demonstrated higher nighttime systolic and diastolic BP, as per the definition of non-dipping patterns.

Table 4. *Clinical patient characteristics depending on dipping pattern*

Variable	Systolic blood pressure		P value	Diastolic blood pressure		P value
	Non dipper (n=35)	Dipper (n=16)		Non dipper (n=41)	Dipper (n=14)	
Age, years, Me (IQR)	69 (63; 75)	70 (69.25; 75)	0.132	68 (63.5; 75.5)	70 (69.75; 75)	0.117
Diabetes mellitus, n (%)	13 (37.1)	13 (81.3)	0.006	20 (48.8)	10 (71.4)	0.215
Smoking, n (%)	10 (28.6)	2 (12.5)	0.296	12 (29.3)	2 (14.3)	0.4781
Dyslipidemia, n (%)	24 (68.6)	16 (100)	0.011	30 (73.2)	14 (100)	0.048
History of stroke, n (%)	5 (14.3)	1 (6.3)	0.651	6 (14.6)	1 (7.1)	0.664
BMI, kg/m^2, M±SD	24.03 (21.88; 25.39)	24.98 (21.64; 27.18)	0.18	23 (19.73; 25)	25.26 (22.54; 27.17)	0.013
Obesity status, n (%)			0.173			0.088
• Underweight	3 (8.6)	0 (0)		7 (17.1)	0 (0)	
• Normal weight	10 (28.6)	6 (37.5)		13 (31.7)	4 (28.6)	
• Overweight	12 (34.3)	12 (12.5)		11 (26.8)	2 (14.3)	
• Obesity	10 (28.6)	8 (50)		10 (24.4)	8 (57.1)	
Waist circumference, cm, M±SD	94 (89; 98)	96.5 (85; 102.25)	0.514	90 (85.5; 98)	97.5 (92.5; 100.75)	0.062
Clinic SBP, mm Hg, M±SD	150 (130; 165)	140 (130; 168.75)	0.539	150 (130; 165)	150 (127.5; 176.25)	0.969
Clinic DBP, mm Hg, M±SD	80 (75; 90)	80 (80; 83.75)	0.734	80 (72.5; 90)	80 (78.75; 80)	0.473
24-hour SBP, mm H, M±SD	135.20±17.37	123.13±13.29	0.017	136.88±17.14	124.0±12.85	0.013
24-hour DBP, mm Hg, M±SD	76.06±9.68	71.94±7.62	0.140	78.27±9.65	71.29±7.52	0.017
Daytime SBP, mm Hg, M±SD	136.0±17.4	125.5±13.4	0.038	137.51±17.0	126.36±12.88	0.029
Daytime DBP, mm Hg, M±SD	76.46±9.78	73.25±7.83	0.255	78.76±9.70	72.79±7.90	0.043
Nighttime SBP, mm Hg, M±SD	130.09±17.74	106.69±14.08	<0.001	133.22±19.14	107.43±14.76	<0.001
Nighttime DBP, mm Hg, M±SD	74.34±9.25	65.06±12.80	0.005	75.41±9.43	64.0±13.20	0.001
Laboratory data:						
Creatinine, µmol/l, Me (IQR)	85.6 (72.1; 101)	70.8 (62.4; 78.3)	0.012	87.3 (71.6; 100.6)	71 (62.8; 86.3)	0.058
Estimated GFR (mL /min /1.73 m2), Me (IQR)	70.1 (52; 79.8)	74.6 (66.5; 85.7)	0.256	71.6 (56.3; 77.4)	73.8 (64.8; 86.2)	0.354
Total	4.2 (3.3; 4.9)	4.5 (4.1; 5.6)	0.113	4.4 (3.7; 4.9)	4.4 (4.1; 5.0)	0.517

Cholesterol, mmol/L, Me (IQR)						
HDL, mmol/L, Me (IQR)	1.1 (0.8; 1.2)	1.0 (0.8; 1.2)	0.535	1.1 (0.9; 1.3)	1.0 (0.8; 1.1)	0.094
LDL, mmol/L, Me (IQR)	2.2 (1.5; 2.8)	2.6 (1.8; 4.4)	0.219	2.6 (1.8; 3.0)	2.6 (1.9; 3.7)	0.517
Triglycerides, mmol/L, Me (IQR)	1.8 (1.2; 2.2)	1.9 (1.5; 3.6)	0.190	1.6 (1.2; 2.3)	1.7 (1.5; 2.3)	0.457
Glucose, mmol/L, Me (IQR)	5.8 (5.1; 8.4)	6.3 (5.2; 9.3)	0.446	6.3 (5.3; 9.3)	6.2 (5.0; 8.2)	0.428
Uric acid, mmol/L, Me (IQR)	373.5 (270.9; 468.5)	319.3 (282.2; 408)	0.187	351.1 (274.9; 444.5)	324.4 (295.6; 435.3)	0.985
Echocardiographic data:						
LV hypertrophy, n (%)	23 (65.7)	6 (37.5)	0.074	23 (56.1)	4 (28.6)	0.121
LVM (g)	165.5 (139.6; 209.9)	142.6 (117.7; 165.6)	0.049	149.4 (121.3; 206.6)	142.6 (122.2; 161.7)	0.511
LVMI, g/m2, M±SD)	106.6 (96.4; 148.4)	93.7 (72.9; 111.5)	0.028	104.3 (85.3; 146.1)	93.7 (75.2; 106.4)	0.170
LV EF, %, , M±SD	65 (62; 70)	65 (63; 69.7)	0.927	67 (62; 71)	63.5 (62.7; 70)	0.588

3.5. Factors associated with target organ damage

Of the total study population, 63.5% (n = 61) had documented TOD [49(51%) patients had LVH, 11 (11.5%) elevated plasma creatinine levels and 25 (26.1%) proteinuria). TOD was more prevalent in non-dipping than in dipping pattern – 36 (70.6%) vs. 5 (38.6%) patients, respectively, P = 0.05.

In multivariate analysis, after adjusting for cardiovascular risk factor like age, gender, diabetes mellitus, smoking, stroke history and obesity, non-dipping patterns (both systolic and diastolic) were associated with target organ damage (odds ratio 7.21; 95% confidence interval 1.47-35.36, p=0.015).

Table 5. ***Factors, associated with target organ damage in Hypertensive Patients in multivariate analysis***

Variables	Odds ratio	95% confidence interval	P
Age	1.02	0.94-1.09	0.667
Female gender	4.49	0.63-31.69	0.132
Diabetes mellitus	2.48	0.71-8.65	0.154
Smoking	4.03	0.51-31.94	0.186
Obesity	1.25	0.36-4.39	0.728
Stroke history	5.14	0.52-50.34	0.160
Non-dipping pattern (both systolic and diastolic)	7.21	1.47-35.36	0.015

IV. DISCUSSION

The present study investigated the prevalence of non-dipping blood pressure patterns among elderly hypertensive patients receiving routine treatment in real-world clinical settings. We discovered a significant proportion of patients who exhibited a lack of nocturnal dipping, indicating an abnormal BP pattern during nighttime sleep. Importantly, we observed a stronger correlation between nocturnal dipping and TOD, emphasizing the clinical significance of ABPM as a predictive tool for assessing cardiovascular risk in hypertensive patients.

Data on the prevalence of non-dipping patterns among older hypertensive patients have been limited. However, our findings are consistent with the study conducted by Pierdomenico et al., which reported a rate of 40.4% for non-dipping patterns among 391 elderly treated hypertensive patients aged 60-90 years [13]. This similarity in prevalence rates suggests a common occurrence of non-dipping patterns in the elderly hypertensive population. In contrast to our results, Carlos et al. conducted a study involving 682 elderly patients aged ≥65 years with grade 1-2 essential hypertension. Interestingly, among these patients, 175 individuals did not receive antihypertensive medication during the study. The rates of non-dippers in untreated and treated patients were 66.3% and 69.4%, respectively [14]. These findings indicate a higher prevalence of non-dipping patterns compared to our study. The variations in the prevalence rates of non-dipping patterns reported in different studies may be attributed to several factors. Differences in the study population characteristics, such as age range and medication status, as observed in the study by Carlos et al. [14], could contribute to the disparities in prevalence rates. Furthermore, variations in the methodology of blood pressure assessment, such as the type of monitoring device and duration of monitoring, may also influence the prevalence estimates.

Despite the differences in prevalence rates, the consistent presence of non-dipping patterns in both studies highlights the importance of recognizing and evaluating this abnormal b pattern among elderly hypertensive patients. Non-dipping patterns have been associated with an increased risk of target organ damage and cardiovascular complications [13, 14]. Therefore, clinicians should consider ABPM as a valuable tool for assessing cardiovascular risk and tailoring treatment strategies in elderly hypertensive patients.

The association between non-dipping patterns and TOD observed in our study aligns with previous evidence linking these two factors [15–18]. For instance, Cuspidi et al. [18] investigated the association between consistent dipping/non-dipping patterns, as determined by ABPM, and subclinical organ damage in untreated hypertensive patients. Their findings demonstrated that non-dippers had higher nighttime BP and heart rate compared to dippers, while there were no significant differences in age, gender, metabolic parameters, or prevalence rates of subclinical TOD, such as LVH (dippers 35% vs. non-dippers 34%) [18]. The study by Cuspidi et al. [18] further supports the notion that non-dipping patterns are associated with nocturnal hypertension and cardiovascular risk. Although the prevalence of LVH was not significantly different between dippers and non-dippers in their study, it is important to consider that LVH is just one manifestation of TOD, and other subclinical organ damage may still be present in non-dippers. Our findings revealed a stronger

correlation between non-dipping patterns and the presence of TOD, indicating that patients with abnormal BP patterns during sleep are at higher risk for cardiovascular complications. This highlights the clinical significance of monitoring nocturnal BP fluctuations and the potential role of non-dipping patterns as a predictive marker for assessing cardiovascular risk in hypertensive patients.

The use of ABPM as a diagnostic tool in assessing non-dipping patterns offers distinct advantages over traditional clinic-based BP measurements. ABPM provides a comprehensive evaluation of BP patterns over a 24-hour period, capturing fluctuations during both daytime and nighttime activities. This enables a more accurate assessment of BP control and the identification of abnormal patterns, such as non-dipping, that may go undetected during routine clinic visits. Incorporating ABPM into routine clinical practice may facilitate early detection of non-dipping patterns and enable proactive interventions to mitigate the risk of TOD [19, 20].

Although our study contributes valuable insights into the prevalence and clinical implications of non-dipping patterns among elderly hypertensive patients, there are some limitations to consider. First, the cross-sectional design of the study limits our ability to establish causal relationships between non-dipping patterns and TOD. Further longitudinal studies are warranted to examine the temporal relationship and determine whether interventions targeting non-dipping patterns can prevent or mitigate TOD. Second, our study focused on a specific population of elderly hypertensive patients, and the generalizability of our findings to other populations should be explored in future research.

V. CONCLUSION

In conclusion, our study underscores the significant prevalence of non-dipping BP patterns among elderly hypertensive patients receiving routine treatment in real-world clinical settings. The observed association between non-dipping patterns and TOD highlights the clinical importance of ABPM in assessing cardiovascular risk. Incorporating ABPM into routine clinical practice may facilitate early detection and proactive management of non-dipping patterns, thereby reducing the risk of adverse cardiovascular outcomes. Further research is needed to validate these findings and explore potential interventions targeting non-dipping patterns to improve patient outcomes in this vulnerable population.

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