

Research Article

Distribution of Dipper, Non-dipper, or Riser Phenotypes in Patients with Mild OSA Untreated with CPAP at UMAA No. 68 in Chihuahua, Mexico

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Abstract

"Obstructive sleep apnea (OSA) is associated with alterations in blood pressure (BP) regulation, influencing hypertension (HTN) control and increasing cardiovascular risk, with three nocturnal BP patterns described: a 10–20% decrease ("dipper"), a 0–10% decrease ("non-dipper"), or an increase during sleep ("riser"). This analytical cross-sectional observational study aimed to identify the distribution of dipper, non-dipper, and riser phenotypes in patients with untreated mild OSA evaluated at UMAA No. 68, Chihuahua. Patients with a diagnosis of mild OSA who were not receiving CPAP therapy were included, and data from 2021–2023 were obtained from the pulmonology service. Twenty-four-hour ambulatory blood pressure monitoring (ABPM) was performed, and SPSS v26 was used for statistical analysis. A total of 70 patients were analyzed (mean age 54.46 ± 15.9 years; 55.7% women), with hypertension documented in 31.4% of participants; overall, 82.9% exhibited a dipper phenotype and 17.1% a riser phenotype. The dipper phenotype predominated among patients with untreated mild OSA, while the riser phenotype was present in 17.1% of cases—approximately twice the prevalence reported in the general population—suggesting that nocturnal BP phenotype should be considered a relevant clinical feature in this population."

Keywords

Obstructive Sleep Apnea, Hypertension, Dipper Phenotype, Riser, Reverse Dipper, Ambulatory Blood Pressure Monitoring (ABPM), Obesity, CPAP

1. Introduction

Obstructive sleep apnea (OSA) is a disorder characterized by recurrent episodes of upper airway obstruction during sleep, leading to intermittent hypoxemia, sleep fragmentation,

and sustained sympathetic activation [1]. These alterations contribute to the development of arterial hypertension, endothelial dysfunction, and increased cardiovascular (CV) risk [2].

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Ambulatory blood pressure monitoring (ABPM) allows the identification of circadian BP phenotypes: dipper, non-dipper, and riser. In healthy individuals, nocturnal BP typically decreases by 10–20%. Smaller reductions define the non-dipper pattern, whereas a nocturnal increase in BP corresponds to the riser phenotype, which is considered the one with the highest cardiovascular risk and is associated with left ventricular hypertrophy, arterial stiffness, and cardiovascular events [4-6].

Large ABPM registries, including a cohort of 26,170 patients, report a prevalence of the riser pattern between 4–11% [7]. In OSA, this prevalence is higher—even in mild disease—due to intermittent hypoxia, sympathetic overactivity, and autonomic dysfunction [8, 9]. The IDACO study demonstrated that nocturnal BP is the strongest predictor of total and cardiovascular mortality [10]. A model of neurogenic nocturnal hypertension induced by OSA has also been described, related to hypoxia, heightened sympathetic activity, and activation of the ascending reticular activating system (ARAS) [11].

Additionally, other studies report that non-dipper and riser patterns predict moderate-to-severe OSA [12]. The 2021 ERS and 2019/2021 AASM guidelines state that nocturnal hemodynamic alterations should influence the evaluation and management of OSA, even in its mild stages [13-16].

Therefore, characterizing the riser phenotype in mild OSA is essential for cardiovascular risk stratification and to optimize therapeutic decision-making.

Study Objective

The primary objective of this study was to identify the distribution of dipper, non-dipper, and riser blood pressure phenotypes in patients with untreated mild OSA evaluated at the Ambulatory Care Medical Unit No. 68 (UMAA No. 68) in Chihuahua.

2. Materials and Methods

Study Design and Population

This study was designed as an observational, cross-sectional, and analytical investigation including all patients evaluated between 2021 and 2023 at the Ambulatory Care Medical Unit No. 68 (UMAA 68) of the Mexican Institute of Social Security (IMSS) in Chihuahua, Mexico. Participants were selected based on a diagnosis of mild obstructive sleep apnea (OSA), defined by an apnea–hypopnea index (AHI) between 5 and 15 events per hour.

Home respiratory polygraphy was performed using the ApneaLink Air® system (ResMed, USA). The following parameters were recorded throughout the assessment: nasal airflow, oxygen saturation (SpO₂), heart rate, respiratory effort, snoring detection, and total recording time.

Eligible participants were adults aged ≥18 years who were not receiving continuous positive airway pressure (CPAP) therapy and who had provided written informed consent. After authorization, clinical records were reviewed to obtain

sociodemographic and clinical information.

All patients also underwent 24-hour ambulatory blood pressure monitoring (ABPM) using the ABPM-50 device (CONTEC®, China). The monitoring protocol included daytime measurements every 20 minutes and nighttime measurements every 30 minutes, following international recommendations. This procedure allowed for the determination of each patient's nocturnal blood pressure phenotype.

The collected data were subsequently analyzed using SPSS statistical software, version 26.

2.1. Statistical Analysis

The statistical analysis began with descriptive statistics. Qualitative variables were reported as absolute frequencies and percentages. A specific analysis was then performed to determine the prevalence of the different nocturnal blood pressure phenotypes within the study population. This analysis also considered participants' general characteristics to provide a comprehensive overview of phenotype distribution in the selected cohort.

Next, a comparison was conducted to determine whether the proportion of patients exhibiting the riser (reverse dipper) phenotype among those with mild OSA (AHI 5–15) differed from the prevalence reported in the general population and in individuals without OSA. An exact binomial proportion test was applied, comparing the observed proportion with the expected prevalence in the general population.

In addition, inferential analyses were performed to compare qualitative variables among the identified groups. Chi-square (χ^2) tests were used to assess associations between categorical variables. For quantitative variables, Student's t-test was employed to compare means between groups, allowing the identification of statistically significant differences when present.

2.2. Ethical Considerations

This study complies with the Mexican General Health Law and with the ethical guidelines established by the Mexican Institute of Social Security (IMSS), and it is classified as a minimal-risk investigation for participants. Confidentiality and anonymity were strictly maintained throughout the study, ensuring that personal data were not disclosed or used outside the research context.

2.3. Equations

One-sample proportion test

This formula was used to compare an observed proportion with an expected proportion [20, 19].

$$Z = \frac{\hat{p} - p_0}{\sqrt{p_0(1-p_0)/n}}$$

Where:

- 1) $\hat{p}$ = observed proportion
- 2) p_0 = expected proportion according to the null hypothesis
- 3) n = sample size

2.4. Tables

Table 1. General Characteristics of the Study Sample.

Variable	Value
Age, years	54.46 ± 15.9
Female sex, n (%)	39 (55.7%)
Hypertension, n (%)	22 (31.4%)
BMI, kg/m ²	29.59

Table 2. Distribution of Phenotypes.

Phenotype	Frequency	Percentage
Dipper	58	82.9%
Non-dipper	0	0%
Riser	12	17.1%
Total	70	100%

Table 3. BMI Category by Blood Pressure Phenotype.

BMI Category	Dipper	Riser
Normal weight	8	0
Overweight	27	8
Obesity Grade 1	16	2
Obesity Grade 2	6	2
Obesity Grade 3	1	0

Table 4. Hypertension Status by Blood Pressure Phenotype.

Hypertension Status	Dipper	Riser
Hypertensive	15	7
Non-hypertensive	43	5

3. Results

Study population and clinical characteristics

A total of 70 IMSS beneficiaries evaluated by pulmonology

specialists between 2021 and 2023 were analyzed. The mean age of participants was 54.46 ± 15.9 years, with a predominance of female sex (55.7%). Among the total sample, 22% had a diagnosis of arterial hypertension (HTN).

Regarding the circadian blood pressure pattern, 82.9% presented a Dipper profile, whereas only 17.1% exhibited a Riser profile. The observed proportion was $p = 0.1714$, with a 95% confidence interval (95% CI) of 0.101–0.276 (Wilson method).

A one-sample proportion test (exact binomial) was applied, comparing the observed proportion of Riser phenotype (17.1%) with the expected prevalence in the general population (8%) [1, 7]. The test yielded:

$$z = \frac{0.1714 - 0.08}{\sqrt{0.08(0.92)/70}} = 2.01$$

Two-tailed p-value = 0.045

One-tailed p-value ($p > 0.08$) = 0.022

Clinical characteristics of the sample

The clinical analysis of the study population showed that 88.6% of participants were overweight or obesity. The mean Body Mass Index (BMI) was 29.35. Additionally, 68.6% of the individuals included in the sample did not have hypertension.

Moreover, the statistical analysis revealed no significant association between categorized BMI and the dipper/riser circadian phenotype, according to the results obtained ($\chi^2 = 3.47$, $df = 4$, $p = 0.482$). This indicates that, within this sample, variations in BMI were not statistically associated with the circadian blood pressure patterns known as dipper and riser.

A significant association was found between the presence of arterial hypertension and the circadian phenotype ($\chi^2 = 4.865$, $df = 1$, $p = 0.027$). Hypertensive subjects showed a higher proportion of the riser phenotype (31.8%) compared to non-hypertensive individuals (10.4%). Fisher's exact test confirmed this association ($p = 0.041$).

4. Discussion

In our cohort, the prevalence of the riser phenotype was 17.1%, notably higher than that reported in the general population (~4–11%) [1]. The meta-analysis by Gavrilaki (10,438 patients) demonstrated that the reverse-dipper phenotype carries the highest cardiovascular (CV) risk (RR 1.33–2.00) [2]. Cuspidi et al. further confirmed its strong association with early cardiovascular damage [3].

The pathophysiological foundations of the riser pattern have been expanded by Kario et al. (2021), who described neurogenic nocturnal hypertension induced by OSA, mediated by intermittent hypoxia and excessive sympathetic tone [4]. This mechanism aligns with the presence of the riser phenotype even in mild OSA. The IDACO analysis concluded that nocturnal blood pressure is the strongest predictor of total and cardiovascular mortality [5]. Kario also demonstrated that

the riser phenotype is associated with a higher incidence of heart failure and major cardiovascular events [6]. Lo et al. reported increased mortality among both non-dippers and risers [7]. In coronary artery disease, Du et al. (2024) showed that the riser phenotype doubled the risk of CV events (HR 2.687), although nocturnal systolic BP remained the dominant predictor [8].

In patients with chronic kidney disease (CKD), Wang et al. demonstrated that the riser phenotype increases overall and cardiovascular mortality up to five-fold [9-16], reinforcing its prognostic relevance in high-risk populations. The consistency of findings between CKD and mild OSA suggests that the riser pattern is an early hemodynamic marker of autonomic dysfunction shared across both pathophysiological processes.

On the other hand, recent studies of lifestyle factors and clinical variables-such as that of Kim et al.-have shown that advanced age, obesity, diabetes, and unhealthy sleep behaviors are strongly associated with non-dipper and riser nocturnal patterns [17]. These findings partially align with our cohort, in which the high prevalence of overweight/obesity may modulate nocturnal BP behavior, even though no direct statistical association was found between BMI and circadian phenotype.

Additionally, modern pathophysiological evidence indicates that obstructive sleep apnea is itself a primary trigger of the non-dipper/riser pattern, independent of traditional risk factors. Crinion et al. demonstrated that intermittent hypoxemia, micro-arousals, and sustained sympathetic activation in OSA directly explain the loss of the physiological nocturnal BP dip [18]. This supports the observation that even individuals with mild OSA may present with a riser phenotype, as occurred in our sample.

The riser pattern also predicts the presence of moderate-to-severe OSA. Genta-Pereira reported an OR $\approx$ 4 for identifying reverse-dippers [10].

From a therapeutic perspective, the 2019 AASM guidelines recommend CPAP as first-line treatment for OSA, including patients with nocturnal hypertension [11]. The 2021 ERS guidelines highlight that individuals with the riser phenotype may require earlier intervention [12]. Studies such as HIPARCO and RHOOSAS confirmed that CPAP reduces nocturnal blood pressure and can revert the riser pattern [13].

Taken together, the available evidence-including recent findings in CKD [16], lifestyle and clinical factors [17], and OSA pathophysiology [18] positions the riser phenotype as an early marker of cardiovascular risk and a priority therapeutic target in the management of mild OSA, supporting the systematic use of ABPM and the consideration of CPAP initiation even in the absence of severe symptoms.

5. Conclusions

The riser phenotype showed a prevalence of 17.1% in mild OSA, doubling that observed in the general population!

Epidemiological, pathophysiological, and prognostic evidence demonstrates that this pattern represents the highest cardiovascular (CV) risk among circadian phenotypes, being associated with increased mortality, cardiovascular events, and target-organ damage [2-6].

The neurogenic model of nocturnal hypertension induced by OSA explains its presence even in mild disease¹¹. Since CPAP therapy can reverse this pattern, the identification of the riser phenotype through ABPM should be considered an additional criterion for initiating treatment in mild OSA, in alignment with the 2021 ERS and 2019/2021 AASM recommendations [11-16].

Abbreviations

BMI	Body Mass Index
BP	Blood Pressure
CKD	Chronic Kidney Disease
CPAP	Continuous Positive Airway Pressure
CV	Cardiovascular
CI	Confidence Interval
ERS	European Respiratory Society
HTN	Hypertension
IDACO	International Database of Ambulatory Blood Pressure in Relation to Cardiovascular Outcomes
IMSS	Mexican Institute of Social Security
OSA	Obstructive Sleep Apnea
RR	Relative Risk
SPSS	Statistical Package for the Social Sciences
UMAA	Ambulatory Medical Care Unit
χ^2	Chi-square test

Conflicts of Interest

The authors declare no conflicts of interest.

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