

The Hidden Burden of COMISA in Hypertensive Obstructive Sleep Apnea Patients

ABSTRACT

Background: Comorbid insomnia and sleep apnea (COMISA) is a frequent but underrecognized condition in patients with obstructive sleep apnea (OSA). While OSA is strongly linked to hypertension, the independent contribution of COMISA to resistant hypertension (RH) remains unclear. This study aimed to investigate the association between COMISA and RH in hypertensive OSA patients and to identify independent predictors of RH.

Methods: This retrospective cross-sectional study included 131 patients diagnosed with both OSA and hypertension who underwent full-night polysomnography (PSG) at a tertiary sleep center. The Insomnia Severity Index (ISI) was used to define COMISA (ISI ≥ 15). Resistant hypertension (RH) was defined as uncontrolled blood pressure despite the use of at least 3 antihypertensive agents of different classes, including a diuretic. Demographic, clinical, and polysomnographic data were analyzed using multiple logistic regression to determine independent predictors of RH.

Results: Of 131 hypertensive OSA patients, 39 (29.8%) met criteria for COMISA. The prevalence of RH was 43.5%. COMISA was significantly more frequent in the RH group (66.7% vs. 33.3%, $P = .006$). In the multiple logistic regression analysis, COMISA (OR = 5.26, $P < .001$, 95% CI: 2.04-13.57) and male sex (OR = 3.24, $P = .010$, 95% CI: 1.36-7.72) were identified as independent predictors of RH, while age, apnea-hypopnea index (AHI), and body mass index (BMI) were not significantly associated.

Conclusion: Comorbid insomnia and sleep apnea (COMISA) markedly increases the risk of RH in hypertensive OSA patients, independent of apnea severity and obesity. These findings highlight COMISA as a distinct cardiovascular phenotype within the OSA spectrum. Routine screening and targeted treatment of insomnia in OSA may represent a critical approach to improving blood pressure control and cardiovascular outcomes.

Keywords: Cardiovascular risk, COMISA, Insomnia, Obstructive sleep apnea, Resistant hypertension

INTRODUCTION

Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder characterized by recurrent upper airway collapse during sleep, resulting in intermittent hypoxemia and sleep fragmentation.^{1,2} It affects up to 20% of middle-aged adults and is strongly associated with hypertension and other cardiovascular diseases.³⁻⁶

The relationship between OSA and hypertension has been well recognized over the past 2 decades. The pathogenesis of OSA-related hypertension is multifactorial. Intermittent hypoxemia, recurrent arousals, and intrathoracic pressure swings contribute to chronic sympathetic activation, oxidative stress, and endothelial dysfunction. These mechanisms promote a non-dipping nocturnal blood pressure pattern and exaggerated morning surges, both of which worsen cardiovascular outcomes.^{4,7} Resistant hypertension (RH), defined as the failure to achieve target blood pressure despite the use of at least 3 antihypertensive agents of different classes, including a diuretic, all at optimal doses, is one of the most clinically significant cardiovascular complications of OSA.^{3,5} Among all hypertensive phenotypes, the estimated prevalence of RH ranges from 12% to 15%.⁵ Ahmad et al,⁸ in their review, reported that the prevalence of hypertension

ORIGINAL INVESTIGATION

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among OSA patients ranges between 30% and 70%, with the highest rates observed in those with severe OSA.⁸ On the other hand, Shiina et al,⁹ in their recent review, summarized that 70-80% of patients with RH have coexisting OSA.⁹

The coexistence of insomnia and OSA, known as comorbid insomnia and sleep apnea (COMISA), has gained attention as a distinct clinical phenotype. Comorbid insomnia and sleep apnea (COMISA) affects 30%-50% of OSA patients and has been linked to increased cardiovascular and metabolic risk, poor CPAP adherence, and reduced quality of life.^{10,11} Although the relationship between OSA and hypertension is well established, the effects of this COMISA phenotype on hypertension and RH remain limited.¹²⁻¹⁴ Comparing OSA in regular hypertensives vs those with RH helps to identify factors that worsen BP control and may guide screening and treatment. Therefore, this study aimed to evaluate the relationship between COMISA and RH in patients with hypertensive OSA and to identify independent predictors of RH within this population.

METHODS

Study Design and Participants

This cross-sectional, retrospective study included 131 patients diagnosed with OSA and hypertension. Data were obtained from the medical records of patients who had undergone full-night diagnostic polysomnography (PSG) at the Sleep Disorders Center.

Inclusion and Exclusion Criteria

Eligible participants were adults aged between 30 and 75 years with a confirmed diagnosis of OSA by PSG and a diagnosis of hypertension receiving antihypertensive treatment by a cardiologist or internal medicine. Patients with a history of central sleep apnea, chronic kidney failure, congestive heart failure, chronic liver disease, inflammatory bowel disease, electrolyte imbalance, or major psychiatric disorders were excluded from the study. Only patients undergoing their first diagnostic PSG were included; therefore, all

participants were CPAP-naïve at baseline, and no patient had received prior CPAP therapy before the assessment.

Data Collection and Measurements

Demographic (age, sex, body mass index (BMI)) and clinical data were retrieved from the hospital database. All patients underwent overnight PSG, and the following parameters were recorded: apnea-hypopnea index (AHI), oxygen desaturation index (ODI), minimum oxygen saturation (min O₂), mean oxygen saturation (mean O₂), and time spent with oxygen saturation <90% (T90).

Daytime sleepiness was assessed using the Epworth Sleepiness Scale (ESS), while insomnia symptoms were evaluated with the Insomnia Severity Index (ISI). A cutoff value of ISI ≥15 was used to define COMISA (comorbid insomnia and sleep apnea).

Definition of Resistant Hypertension

All patients were evaluated, and additional differential diagnostic assessments were conducted by both cardiology and internal medicine specialists. Office blood pressure was measured according to current guidelines as the mean of 3 readings taken at 5-minute intervals after the participant had been seated for at least 5 minutes. Resistant hypertension (RH) was defined as uncontrolled BP despite optimal doses of 3 antihypertensive drug classes, including a diuretic. Patients who achieved blood pressure control or were on ≤2 antihypertensive agents were classified as having non-resistant hypertension.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics 26.0 (IBM Corp., Armonk, NY, USA) and Python (statsmodels, scipy) software. The normality of data distribution was tested using the Shapiro-Wilk test. Normally distributed continuous variables were expressed as mean ± standard deviation (SD), whereas non-normally distributed variables were presented as median (interquartile range, IQR). Group comparisons were made using the student's *t*-test or Mann-Whitney *U*-test, and categorical variables were analyzed with the chi-square or Fisher's exact test. Independent predictors of RH were determined using multiple logistic regression analysis (Enter method). A *P* value < .05 was considered statistically significant. To reduce the risk of overfitting, multiple logistic regression was performed following the event-per-variable (EPV ≥10) principle. Only clinically meaningful covariates supported by previous literature were included in the final model.

RESULTS

A total of 131 patients diagnosed with PSG as OSA and hypertension were included in the study. The mean age of the participants was approximately 57 years, and the mean BMI was 33 kg/m². Among all patients, 47% were female and 53% were male.

According to the ISI score, 39 patients (29.8%) were classified in the COMISA group (ISI ≥15), while 92 patients (70.2%) were in the OSA-only group (ISI <15).

HIGHLIGHTS

- Comorbid insomnia and sleep apnea (COMISA) was significantly more common in patients with resistant hypertension (RH) than in those with controlled hypertension.
- COMISA independently increased the risk of RH by more than fivefold (OR = 5.3), regardless of apnea severity or obesity.
- Male sex was identified as another independent predictor of RH in hypertensive obstructive sleep apnea (OSA) patients.
- Polysomnographic parameters such as apnea-hypopnea index (AHI), oxygen desaturation index (ODI), and nocturnal desaturation were not associated with RH.
- Early identification and management of insomnia symptoms in OSA patients may improve blood pressure control and reduce cardiovascular risk.

Table 1. Baseline Characteristics of the Study Population According to Resistant Hypertension Status

	RH (-) n = 74 (56.5%)	RH (+) n = 57 (43.5%)	P
Age*	55.0 (50.5-61.0)	60.0 (47.0-67.0)	.362
BMI*	31.9 (28.4-35.2)	33.0 (29.2-37.2)	.335
Insomnia Severity Index (ISI)*	5.0 (2.8-10.0)	8.0 (3.0-16.2)	.019
Epworth*	9.0 (5.0-12.0)	7.0 (6.0-11.0)	.427
AHI*	33.5 (17.6-51.8)	39.0 (22.3-62.0)	.355
ODI*	35.5 (20.0-56.6)	36.5 (23.2-60.8)	.736
Min O ₂ *	75.0 (68.0-81.0)	74.0 (64.2-80.0)	.452
Mean O ₂ *	93.0 (92.0-95.0)	92.0 (91.0-95.0)	.439
T90 (%) *	12.0 (3.9-34.2)	19.9 (8.2-35.8)	.132
Gender (Female) **	33 (67.4%)	16 (32.6%)	.024
COMISA (ISI≥15) **	13 (33.3%)	26 (66.7%)	.006
Smoke (1=Non-Smoker, 2=Ex-Smoker, 3=Smoker) **	1:50.0%/ 2:45.7%/ 3:63.6%	1:50.0%/ 2:54.3%/3:36.4%	.164

AHI, apnea-hypopnea index; BMI, body mass index; ISI, insomnia severity index; Min O₂, minimum oxygen saturation; Mean O₂, mean oxygen saturation; ODI, oxygen desaturation index; RH, resistant hypertension; T90, time spent with oxygen saturation <90%.

*Mann-Whitney U-test, Median (Q1-Q3), **chi-square test, %.

When patients with and without RH were compared, no significant differences were observed in terms of age, BMI, ESS, AHI, ODI, mean or minimum oxygen saturation, or T90 percentage ($P > .05$). However, the ISI score was significantly higher in the RH group [8.0 (3.0-16.2) vs. 5.0 (2.8-10.0); $P = .019$]. The proportion of women was lower, and the prevalence of male sex was significantly higher among patients with RH ($P = .024$). In addition, the frequency of COMISA (ISI ≥15) was significantly greater in patients with RH (67.7% vs. 32.3%, $P = .006$). No significant differences were found between the two groups regarding smoking status ($P = 0.164$) (Table 1).

When patients were grouped according to the presence of COMISA, no significant differences were found between the COMISA (ISI ≥15) and OSA-only (ISI <15) groups in terms of age, BMI, ESS, AHI, ODI, minimum or mean oxygen saturation, or T90 percentage (all $P > .05$). However, the prevalence of RH (grades 1-2) was significantly higher in the COMISA group compared to the OSA-only group (67.7% vs. 38.1%, $P = .006$). This finding supports that the presence of insomnia symptoms in OSA patients is associated with an increased risk of RH (Table 2).

When stratified by sex, male patients demonstrated a significantly higher prevalence of RH compared to females (54.9% vs. 32.6%, $P < .001$). Age was slightly lower in men, and ODI values were significantly higher in males ($P = .030$), whereas no significant differences were observed in BMI, ISI, ESS, AHI, mean SpO₂, or T90 between groups (Table 3).

In the multiple logistic regression analysis, COMISA (ISI ≥15) and male sex were identified as significant independent predictors of RH. The presence of COMISA increased the likelihood of RH by approximately 5.3-fold (OR = 5.26, $P < .001$, 95% CI = 2.04-13.57), while male sex increased the risk by approximately 3.2-fold (OR = 3.24, $P = .010$, 95% CI = 1.36-7.72). Age, AHI, and BMI were included in the final model as clinically relevant covariates, selected based on prior evidence and maintaining an acceptable events-per-variable threshold to avoid model overfitting. However, these variables were not statistically significant predictors in the adjusted analysis (all $P > .05$) (Table 4, Figure 1).

DISCUSSION

The present study revealed that COMISA and male sex were independent predictors of RH among hypertensive OSA

Table 2. Comparison of Clinical and Polysomnographic Parameters Between COMISA (ISI ≥ 15) and OSAS (ISI < 15) Groups

Variables	OSAS (ISI<15) n = 92	COMISA (ISI ≥ 15) n = 39	P
Age (Years)*	57.13 ± 10.79	56.61 ± 13.41	.843
BMI (kg/m ²)**	32.7 (28.7-37.5)	32.5 (28.9-35.8)	.998
Epworth Sleepiness Scale**	8.0 (6.0-12.0)	8.0 (6.0-11.0)	.896
Apnea-Hypopnea Index (events/h)**	37.0 (21.5-57.0)	34.0 (15.0-60.2)	.594
Oxygen Desaturation Index (events/h)**	38.0 (21.4-59.8)	30.0 (17.5-51.4)	.262
Minimum O ₂ saturation (%)**	74.0 (66.0-80.0)	77.5 (69.5-81.0)	.131
Mean O ₂ saturation (%)**	93.0 (91.0-95.0)	92.0 (91.0-94.0)	.790
Time with O ₂ <90% (T90, %)**	15.0 (5.0-37.0)	11.9 (3.9-30.4)	.540
Resistant hypertension, n (%) ***	20 (38.1%)	37 (67.7%)	0.006

AHI, apnea-hypopnea index; BMI, body mass index; ISI, insomnia severity index; ODI, oxygen desaturation index; Min O₂, minimum oxygen saturation; Mean O₂, mean oxygen saturation; T90, time spent with oxygen saturation <90%; RH, resistant hypertension.

* t-Test, mean ± SD; ** Mann-Whitney U-test, median (Q1-Q3); ***chi-square test.

Table 3. Comparison of Clinical and Polysomnographic Parameters Between Female and Male Patients

Variables	Female (n=49)	Male (n=82)	P
Age (years)*	58.0 (12.0)	55.0 (15.0)	.036
BMI (kg/m ²)*	31.22 (6.32)	32.32 (7.31)	.524
Insomnia Severity Index (ISI)*	8.00 (12.00)	6.50 (7.00)	.282
Epworth Sleepiness Scale*	8.0 (6.0)	8.0 (6.0)	.954
Apnea–Hypopnea Index (events/h)*	28.00 (32.80)	39.50 (35.88)	.069
Oxygen Desaturation Index (events/h)*	29.50 (34.50)	38.08 (39.00)	.030
Minimum O ₂ saturation (%)*	74.50 (14.75)	76.00 (12.25)	.422
Mean O ₂ saturation (%)*	92.0 (3.25)	93.0 (4.00)	.486
Time with O ₂ <90% (T90, %)*	14.00 (28.32)	12.00 (31.75)	.441
Resistant hypertension, n (%)**	16 (32.6%)	45 (54.9%)	< .001

AHI, apnea–hypopnea index; BMI, body mass index; ISI, insomnia severity index; ODI: oxygen desaturation index; Min O₂, minimum oxygen saturation; Mean O₂, mean oxygen saturation; RH, resistant hypertension; T90, time spent with O₂ <90%.

*Mann–Whitney U test, median (IQR); **chi-square.

patients. The presence of insomnia increased the likelihood of RH by more than fivefold, even after adjusting for apnea severity and obesity. These results support the growing evidence that COMISA represents a distinct phenotype associated with an additive cardiovascular burden.¹²⁻¹⁷

The prevalence of OSA among middle-aged adults ranges from 24%-26% in men and 17%-28% in women.^{1,18} This rate is substantially higher in individuals with hypertension, reaching 30%-80%, and may rise to as high as 64%-83% in those with RH.^{5,19,20} In our study, the prevalence of RH was 43.5%. Given this strong overlap, identifying reliable predictors is crucial for early screening and management. Accurate assessment of blood pressure and adherence to recommended monitoring strategies are also essential components of adequate hypertension control, as demonstrated in recent studies.²¹

AHI values above 30 events per hour have been particularly associated with uncontrolled or non-dipping blood pressure patterns. Another significant predictor is ODI and minimum nocturnal oxygen saturation. Persistent nocturnal hypoxemia triggers sympathetic overactivation, oxidative stress, and endothelial dysfunction, all of which perpetuate

Table 4. Multiple Logistic Regression Analysis for Predictors of Resistant Hypertension

Variables	B	Odds Ratio (Exp B)	P	95% Confidence Interval for OR
COMISA	1.662	5.26	< .001	2.04-13.57
Age (years)	0.030	1.03	.114	0.99-1.07
AHI (events/h)	0.002	1.00	.786	0.98-1.02
Sex (male)	1.176	3.24	.010	1.36-7.72
BMI (kg/m ²)	0.035	1.03	.279	0.97-1.10

AHI, apnea–hypopnea index; BMI, body mass index; Exp(B), exponentiated B coefficient; OR, odds ratio; RH, resistant hypertension.

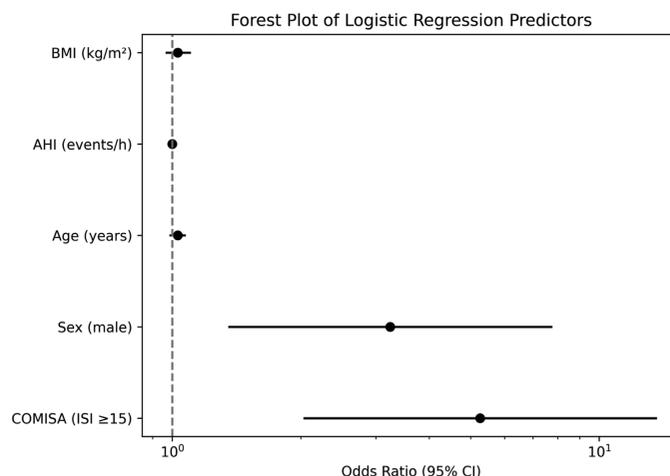


Figure 1. Forest plot displaying odds ratios (OR) and 95% confidence intervals for predictors of resistant hypertension in hypertensive OSA patients.

RH. Several studies have demonstrated that an ODI >15 or a mean SpO₂ below 90% independently predicts RH in OSA patients.^{5,20}

The relationship between COMISA and RH appears multifactorial and synergistic.

OSA-related intermittent hypoxemia contributes to oxidative stress, inflammation, endothelial dysfunction, and activation of the renin–angiotensin–aldosterone system, all of which promote sustained hypertension.^{4,7,22} Conversely, insomnia induces chronic inflammation by arousals and hypothalamic–pituitary–adrenal axis activation, leading to elevated nocturnal cortisol and increased sympathetic tone.^{10,11,23} The coexistence of both disorders may therefore amplify autonomic and neuroendocrine stress, resulting in greater cardiovascular strain. Recent studies using heart rate variability have shown marked autonomic imbalance in COMISA compared to OSA alone,²⁴ supporting this synergistic mechanism. Persistent sleep fragmentation may also blunt nocturnal dipping and sustain 24-hour hypertension by impairing baroreflex sensitivity.^{16,22}

Our findings are consistent with recent longitudinal studies. Wu¹³ demonstrated that insomnia independently predicted the development of RH in OSA patients, while Draelants¹² reported that COMISA was associated with a higher 10-year cardiovascular risk.¹²⁻¹⁴ These observations align with previous systematic reviews and meta-analyses, including Ahmed et al,²⁵ which confirmed that OSA significantly increases the risk of RH and poor antihypertensive response. In a population-based cohort, Frisk et al. found that COMISA correlated with uncontrolled hypertension, reinforcing the clinical relevance of this interaction.²⁶ Furthermore, Quan et al¹⁶ and Pejovic¹⁷ observed that insomnia symptoms were linked to sustained sympathetic activation and increased incidence of hypertension, even in non-OSA populations. Recent cardiovascular studies have also demonstrated that inadequately controlled or treatment-RH is associated with a higher risk of adverse clinical outcomes, underscoring the need for early identification of high-risk hypertensive phenotypes.²⁷ Taken

together, these studies indicate that insomnia is not a coincidental comorbidity but a major modifier of OSA's cardiovascular consequences.

From a practical standpoint, these results underscore the importance of screening for insomnia symptoms in all OSA patients, particularly those with suboptimal blood pressure control despite adequate pharmacologic therapy. In clinical workflow, administering a brief tool such as the ISI at the initial sleep clinic visit or hypertension evaluation may help identify COMISA early. Insomnia has been shown to impair adherence to continuous positive airway pressure (CPAP) treatment,^{15,28} reducing its antihypertensive efficacy. Combined management approaches integrating cognitive behavioral therapy for insomnia (CBT-I) with CPAP have been shown to improve sleep continuity, therapy adherence, and blood pressure outcomes.^{16,29,30} Moreover, the incorporation of COMISA status into risk prediction models, such as the nomogram developed by Lin,³¹ could enable early identification of high-risk patients and personalized management strategies. Clinicians should recognize COMISA as a high-risk cardiovascular phenotype requiring multidisciplinary management, including pulmonology, cardiology, and behavioral sleep medicine.

One of the limitations of our study was the inability to perform 24-hour ambulatory blood pressure monitoring; therefore, we could not evaluate the distinction between dipper and non-dipper patterns. However, all medications used by the patients were verified through the pharmacy records, and additional differential diagnostic assessments were conducted by both cardiology and internal medicine specialists. The main strengths of this study include objective polysomnographic assessment, validated evaluation of ISI, and robust multiple modeling. However, the retrospective and single-center design limits generalizability, and unmeasured confounders such as sodium intake, medication adherence, and secondary hypertension causes cannot be excluded. The study was conducted in a tertiary referral sleep center, which may have led to a selection of patients with more severe symptoms or comorbidities compared with the general population. Therefore, the generalizability of our findings to primary care or community-based OSA cohorts may be limited. The use of self-reported scales (ESS, ISI) may introduce recall bias. Another limitation of our study is the absence of objective sleep fragmentation parameters such as arousal index. Although ISI provided a subjective assessment of insomnia symptoms, integrating arousal-based PSG markers could further clarify the physiological interaction between COMISA and RH. In addition, the cross-sectional design precludes establishing causality between COMISA and RH. Whether insomnia contributes to RH, whether the hypertensive burden worsens sleep quality, or whether both share common autonomic and neuroendocrine pathways remains uncertain; therefore, our findings should be interpreted as associative. Future multicenter prospective studies incorporating arousal scoring, continuous blood pressure monitoring, and mechanistic biomarkers (e.g., catecholamines, endothelin-1) are warranted. Moreover, advanced analytical approaches such as machine learning models may

enhance individualized risk prediction in OSA and COMISA populations.³²

CONCLUSION

In conclusion, the coexistence of insomnia and OSA significantly increases the risk of RH, independent of apnea severity and obesity. COMISA appears to represent a distinct cardiovascular phenotype within the OSA spectrum.

Routine assessment and targeted treatment of insomnia in OSA patients through behavioral and pharmacologic interventions may represent a critical yet underutilized approach to improving blood pressure control and reducing long-term cardiovascular risk.

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Ethics Committee Approval: This study was approved by the Hitit University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (Approval No.: 2025-135; Date: July 2, 2025).

Informed Consent: Since this study was designed as a retrospective chart review, the requirement for informed consent was waived by the ethics committee.

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REFERENCES

1. Benjafield AV, Ayas NT, Eastwood PR, et al. Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis. *Lancet Respir Med*. 2019;7(8): 687-698. [CrossRef]
2. Javaheri S, Barbé F, Campos-Rodriguez F, et al. Sleep apnea: types, mechanisms, and clinical cardiovascular consequences. *J Am Coll Cardiol*. 2017;69(7):841-858. [CrossRef]
3. Calhoun DA, Jones D, Textor S, et al. Resistant hypertension: diagnosis, evaluation, and treatment: a scientific statement from the American Heart Association Professional Education Committee of the Council for High Blood Pressure Research. *Circulation*. 2008;117(25):e510-e526. [CrossRef]
4. Kario K. Obstructive sleep apnea syndrome and hypertension: ambulatory blood pressure. *Hypertens Res*. 2009;32(6): 428-432. [CrossRef]
5. Pedrosa RP, Drager LF, Gonzaga CC, et al. Obstructive sleep apnea: the most common secondary cause of hypertension associated with resistant hypertension. *Hypertension*. 2011;58(5):811-817. [CrossRef]

6. Yeghiazarians Y, Jneid H, Tietjens JR, et al. Obstructive sleep apnea and cardiovascular disease: a scientific statement from the American Heart Association. *Circulation*. 2021;144(3):e56-e67. [\[CrossRef\]](#)
7. Shiina K. Obstructive sleep apnea -related hypertension: a review of the literature and clinical management strategy. *Hypertens Res*. 2024;47(11):3085-3098. [\[CrossRef\]](#) Epub 2024 Aug 29.
8. Ahmad M, Makati D, Akbar S. Review of and updates on hypertension in obstructive sleep apnea. *Int J Hypertens*. 2017; 2017:1848375. [\[CrossRef\]](#)
9. Shiina K. Obstructive sleep apnea -related hypertension: a review of the literature and clinical management strategy. *Hypertens Res*. 2024;47(11):3085-3098. [\[CrossRef\]](#)
10. Fernandez-Mendoza J, Vgontzas AN, Liao D, et al. Insomnia with objective short sleep duration and incident hypertension: the Penn State Cohort. *Hypertension*. 2012;60(4):929-935. [\[CrossRef\]](#)
11. Li L, Gan Y, Zhou X, et al. Insomnia and the risk of hypertension: A meta-analysis of prospective cohort studies. *Sleep Med Rev*. 2020;56:101403. [\[CrossRef\]](#)
12. Draelants L, Point C, Wacquier B, Lanquart JP, Loas G, Hein M. 10-Year Risk for Cardiovascular Disease Associated with COMISA (Co-Morbid Insomnia and Sleep Apnea) in Hypertensive Subjects. *Life (Basel)*. 2023;13(6):1379. Published 2023 Jun 13. [\[CrossRef\]](#)
13. Wu H, Guo Y. Risk of resistant hypertension associated with insomnia in patients with obstructive sleep apnea. *Sleep Med*. 2023;101:445-451. [\[CrossRef\]](#)
14. Wu H, Xie J, Wu C. The role of insomnia in the development of resistant hypertension in uncontrolled hypertensive patients with obstructive sleep apnea: A prospective study. *Sleep Med*. 2025;131:106508. [\[CrossRef\]](#)
15. Balcan B, Peker Y. Continuous positive airway pressure treatment of resistant hypertension in obstructive sleep apnea: a clinical dilemma? *Sleep*. 2025;48(10):zsaf225. [\[CrossRef\]](#)
16. Quan SF, Weaver MD, Czeisler ME, et al. Sleep and long COVID: preexisting sleep issues and the risk of post-acute sequelae of SARS-CoV-2 infection in a large general population using 3 different model definitions. *J Clin Sleep Med*. 2025;21(2):249-259. [\[CrossRef\]](#)
17. Pejovic S, Vgontzas AN, Fernandez-Mendoza J, et al. Obstructive sleep apnea comorbid with insomnia symptoms and objective short sleep duration is associated with clinical and preclinical cardiometabolic risk factors: Clinical implications. *Sleep Med*. 2024;124:115-119. [\[CrossRef\]](#)
18. Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM. Increased prevalence of sleep-disordered breathing in adults. *Am J Epidemiol*. 2013;177(9):1006-1014. [\[CrossRef\]](#)
19. Gonçalves SC, Martinez D, Gus M, et al. Obstructive sleep apnea and resistant hypertension: a case-control study. *Chest*. 2007;132(6):1858-1862. [\[CrossRef\]](#)
20. Logan AG, Perlikowski SM, Mente A, et al. High prevalence of unrecognized sleep apnoea in drug-resistant hypertension. *J Hypertens*. 2001;19(12):2271-2277. [\[CrossRef\]](#)
21. Şirin H, Arslan A, Güneş İS, et al. Comparison of home blood pressure monitoring with and without training: does adherence to the recommended instructions overlook hypertension? *Anatol J Cardiol*. 2024;28(10):499-506. [\[CrossRef\]](#)
22. Drager LF, Togeiro SM, Polotsky VY, Lorenzi-Filho G. Obstructive sleep apnea: a cardiometabolic risk in obesity and the metabolic syndrome. *J Am Coll Cardiol*. 2013;62(7):569-576. [\[CrossRef\]](#)
23. Vgontzas AN, Chrousos GP. Sleep, the hypothalamic-pituitary-adrenal axis, and cytokines: multiple interactions and disturbances in sleep disorders. *Endocrinol Metab Clin N Am*. 2002;31(1):15-36. [\[CrossRef\]](#)
24. Martín-Montero A, Vaquerizo-Villar F, García-Vicente C, Gutiérrez-Tobal GC, Penzel T, Hornero R. Heart rate variability analysis in comorbid insomnia and sleep apnea (COMISA). *Sci Rep*. 2025;5(1):17574. [\[CrossRef\]](#)
25. Ahmed AM, Nur SM, Xiaochen Y. Association between obstructive sleep apnea and resistant hypertension: systematic review and meta-analysis. *Front Med (Lausanne)*. 2023;10:1200952. [\[CrossRef\]](#)
26. Kobayashi Frisk M, Bergqvist J, Svedmyr S, Diamantis P, Bergström G, Zou D. Co-morbid Insomnia and Sleep Apnea Is Associated with Uncontrolled Hypertension in a Middle-aged Population. *Ann Am Thorac Soc*. Published online September 8, 2025. [\[CrossRef\]](#)
27. Zuo C, Li X, Guan Y, et al. Influence of aging on outcomes of Sacubitril/Valsartan in hypertensive patients with heart failure: A multicenter retrospective study. *Anatol J Cardiol*. 2024; 28(4):194-200. [\[CrossRef\]](#)
28. Weaver TE, Grunstein RR. Adherence to continuous positive airway pressure therapy: the challenge to effective treatment. *Proc Am Thorac Soc*. 2008;5(2):173-178. [\[CrossRef\]](#)
29. Sweetman A, Reynolds C, Lack L, et al. Effect of high-risk sleep apnea on treatment-response to a tailored digital cognitive behavioral therapy for insomnia program: a quasi-experimental trial. *Front Sleep*. 2024;3:1355468. [\[CrossRef\]](#)
30. Sivarajan V, Ganesh AV, Subramani P, et al. Prevalence and genomic insights of carbapenem resistant and ESBL producing Multidrug resistant *Escherichia coli* in urinary tract infections. *Sci Rep*. 2025;15(1):2541. [\[CrossRef\]](#)
31. Lin H, Zhou C, Li J, Ma X, Yang Y, Zhu T. A risk prediction nomogram for resistant hypertension in patients with obstructive sleep apnea. *Sci Rep*. 2024;14(1):6127. Published 2024 Mar 13. [\[CrossRef\]](#)
32. Mouchati C, Grigg-Damberger M, El Ahdab J, et al. High-risk Obstructive sleep apnea (OSA), insomnia, and comorbid OSA (COMISA) increase likelihood of poor functional status in neurological and psychiatric populations. *Sleep Med*. 2025;133:106600. [\[CrossRef\]](#) Epub 2025 May 23.