Escola Superior
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IMPACTO DA MENOPAUSA NOS DISTÚRBIOS DO SONO: UMA *SCOPING REVIEW*

VOLUME 1

Dissertação no âmbito do Mestrado de Fisiologia Clínica com especialização em fisiopatologia do sono e Ventilação Não Invasiva, orientada pelo Professor Telmo Pereira e apresentada à Escola Superior de Tecnologia da Saúde do Politécnico de Coimbra

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Impacto da menopausa nos distúrbios do sono: uma *Scoping Review*

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Resumo

Introdução: Os distúrbios do sono são queixas recorrentes nas mulheres na pós-menopausa, principalmente os despertares noturnos e as insónias iniciais, e afetam entre 28% a 63% das mulheres. Esta *scoping review* teve como objetivo descrever o atual conjunto de literatura que avaliou o impacto dos distúrbios do sono na menopausa.

Métodos: Foi realizada uma pesquisa sistemática na PubMed, Cochrane and Scielo Library a 19 de fevereiro de 2025. A revisão incluiu estudos observacionais dos últimos 10 anos utilizando polissonografia (PSG) ou actigrafia na menopausa. Os resultados foram extraídos desses artigos.

Resultados: A pesquisa identificou 312 estudos, dos quais 223 foram excluídos. Foram lidos os títulos e resumos dos restantes 89 artigos e, após aplicação dos critérios de inclusão e exclusão, foram selecionados 31 para texto integral. Um total de 26 artigos publicados foram incluídos nesta *scoping review*. Os distúrbios do sono estudados foram a insónia, a arquitetura do sono, a apneia obstrutiva do sono (AOS), a síndrome da AOS, a síndrome de hipoventilação por obesidade, os distúrbios respiratórios do sono e a síndrome das pernas inquietas. As mulheres na pós-menopausa apresentaram perda de robustez circadiana e agravamento da qualidade do sono, com aumento do estado de vigília após o início do sono e do índice de despertar, bem como diminuição do tempo total de sono e da eficiência do sono. Também os distúrbios respiratórios do sono se tornam mais graves com a idade, sendo que por cada ano adicional na menopausa o Índice Apneia-Hipopneia (IAH) está associado a um aumento de 4% e de 7% na probabilidade de ter um IAH de 15 ou mais.

Conclusões: Concluindo, esta revisão revelou interesse no campo do sono para as mulheres na menopausa. Os distúrbios do sono neste grupo de mulheres exigem que as queixas sejam valorizadas e avaliadas adequadamente. Uma vez que as flutuações hormonais causam distúrbios do sono e da respiração, deve ser considerado o tratamento adequado. Estudos futuros devem ser conduzidos para abordar a falta de informação sobre determinadas patologias, como a respiração de Cheyne-Stokes e a apneia central do sono.

Palavras-chave: Menopausa, distúrbios do sono, polissonografia, revisão

Abstract

Introduction: Sleep disorders are recurrent complaints in postmenopausal women, mainly nocturnal awakenings and initial insomnia, and affects between 28% and 63% of women. This scoping review aimed to describe the current body of literature that has evaluated the impact of sleep disturbances on menopause.

Methods: A systematic search was performed in PubMed, Cochrane Library and Scielo on February 19, 2025. The review included observational studies from the last 10 years using polysomnography (PSG) or actigraphy in menopause. The results were extracted from these articles.

Results: The search identified 312 studies, of which 223 were excluded. The titles and abstracts of the remaining 89 articles were read and, after applying the inclusion and exclusion criteria, 31 were selected for full text. A total of 26 published articles were included in this Scoping Review. The sleep disorders studied was insomnia, sleep architecture, obstructive sleep apnea (OSA), OSA syndrome, obesity hypoventilation syndrome, sleep-disordered breathing and restless leg syndrome. Postmenopausal women had a loss of circadian robustness and worsening sleep quality with an increase in wakefulness after sleep onset and arousal index, and a decrease in total sleep time and sleep efficiency. Also sleep-disordered breathing becomes more severe with age, as for each additional year in menopause the Apnea-Hypopnea (AHI) is associated with a 4% increase and a 7% increase in the likelihood of having an AHI of 15 or greater.

Conclusions: In conclusion, this review revealed interest in the field of sleep for menopausal women. Sleep disorders in this group of women require that complaints be valued and evaluated appropriately. As hormonal fluctuations cause sleep and breathing disorders, appropriate treatment should be considered. Future studies should be conducted to address the lack of information on certain pathologies, such as Cheyne-Stokes respiration and central sleep apnea.

Keywords: Menopause, sleep disorders, polysomnography, review

List of abbreviations

AHI – apnea-hypopnea index

BMI – body mass index

EEG – electroencephalogram

ePOSA – exclusive POSA

FSH – follicle-stimulating hormone

LH - luteinizing hormone

NC – neck circumference

NREM – non-REM

OHS – obesity hypoventilation syndrome

OSA – obstructive sleep apnea

OSAS – obstructive sleep apnea syndrome

POSA – positional OSA

PLMS – periodic limbs movement

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Prisma-ScR – PRISMA extension for scoping reviews

PSG – polysomnography

RDI – restiratory disturbance index

REM – rapid eye movemente

RLS – restless legs syndrome

SDB – Sleep-disordered breathing

SE – sleep efficiency

SRMDs – sleep-related movement disorders

SWS – slow wave sleep

TST – total sleep time

USA – United States of America

WC – waist circumference

WHR – waist-hip ratio

WASO – wakefulness after sleep onset

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1. Introduction

Sleep disorders are recurrent complaints in postmenopausal women, mainly nocturnal awakenings and initial insomnia (Zolfaghari et al., 2020). In clinical terms, menopause is diagnosed after one year of amenorrhea without any other associated cause. Pre-menopause includes the fertile age until menopause and post-menopause begins with the last menstrual period, called late after 6 years. The menopausal transition or perimenopause is the period with changes in the regularity of the menstrual cycle that ends with the last menstruation (Secção Portuguesa da Menopausa, 2021). During the climacteric period, there is a decline in ovarian function and encompasses the three phases previously described (Utian, 1999). The main signs and symptoms of climacteric are from the decline in estrogen production. Estrogens act mainly on the reproductive organs but also on the cardiovascular, musculoskeletal, immune, gastrointestinal and neurological systems (McEwen, 1999). The decline in estrogen contributes to disrupted sleep, and progesterone may also be involved in sleep disturbances, as it has a sleep-inducing effect on brain pathways (Currie, 2024).

Sleep disorders are mainly divided into 6 groups according to the International Classification of Sleep Disorders (3rd version), (i) insomnia disorders, (ii) sleep-related breathing disorders, (iii) central disorders of hypersomnolence, (iv) circadian rhythm sleep-wake disorders, (v) parasomnias and (vi) sleep-related movement disorders (Sateia, 2014). Polysomnography (PSG) is considered the gold standard for diagnosing sleep disorders. PSG collects physiological parameters during sleep, using electroencephalogram, electrooculogram, electromyogram, electrocardiogram and pulse oximetry (Rundo & Downey, 2019).

Insomnia disorder is characterized by poor sleep quality, whether it is at the beginning of sleep (initial insomnia), waking up in the middle of the night with difficulty returning to sleep (intermediate insomnia), or waking up earlier than desired (final insomnia) (David et al., n.d.). It is considered acute if symptoms occur less than 3 months and chronic if symptoms occur 3 or more times per week for 3 months or longer (Wilson & Attarian HP, 2016).

Sleep-related breathing disorders are characterized by abnormal breathing patterns, or pauses in breathing, and by insufficient ventilation during sleep, and include obstructive sleep apnea (OSA) (Resmed, 2025). This is characterized by repeated episodes of total or partial airway obstruction, resulting in fragmented sleep and intermittent desaturation. Obstructive sleep apnea syndrome (OSAS) is characterized by in the presence of symptoms such as snoring, sudden awakenings with choking or suffocating sensations, recurrent awakenings, restless sleep, morning headaches, feeling of unrefreshing sleep, among others (SNS24, 2023).

Sleep-related movement disorders (SRMDs) are caused by movement during or before sleep and make it difficult to fall asleep or stay asleep. SRMDs include four types, including Restless Legs Syndrome (RLS), a disorder that causes an irresistible urge to move the legs and an uncomfortable feeling when lying down, making it difficult to get comfortable enough to fall asleep (UCI Health, n.d.).

Sleep disturbances in menopause affects between 28% and 63% of women (Currie, 2024). A 6-year follow-up of midlife women showed less total sleep time and more wakefulness after sleep onset. PSG hypnograms from a woman who transitioned from premenopause to perimenopause are shown in Figure 1 (Lampio et al., 2017).

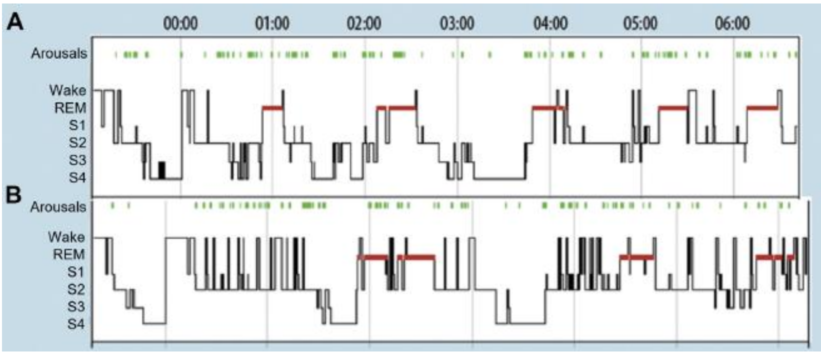

Figure 1 – Hypnograms of a women during her premenopausal baseline (A) and at a follow-up visit 6 years later (B), when was perimenopausal (Lampio et al., 2017)

Currently, sleep disorders in women during menopause are not as valued as in men. Thus, reviewing all studies allow to draw attention to the needs of this group. A scoping review is a type of synthesis that uses systematic research to map evidence on a topic and identify key concepts. Reporting items follow the PRISMA extension for scoping reviews (Prisma-

ScR) checklist (Tricco et al., 2018). This scoping review aimed to describe the current body of literature that has evaluated the impact of sleep disturbances on menopause.

2. Methods

The methods section includes the search strategy, exclusion criteria, study selection, eligibility criteria and data extraction. This *Scoping review* was conducted according to the PRISMA-ScR checklist (Tricco et al., 2018).

2.1. Search Strategy

A systematic search was performed in PubMed, Cochrane Library and Scielo on February 19, 2025 with the terms (“menopause” OR “menopausal”) AND (“sleep disorders” OR “sleep disturbances” OR “insomnia” OR “sleep-related breathing disorders” OR “apnea” OR “OSA” OR “central disorders hypersomnolence” OR “circadian rhythm sleep-wake” OR “circadian rhythm” OR “parasomnias” OR “sleep-related movement disorders” OR “restless legs” OR “RLS” OR “somnolence” OR “rapid eye movement” OR “RBD” OR “sleep complaints” OR “symptoms” OR “sleep latency”) AND (“polysomnography” OR “PSG” OR “polygraphic” OR actigraphy).

Articles published more than 10 years ago, without full text, about animals or males and other languages except English, Portuguese, Spanish and Italian, were excluded. Mendeley’s desktop allowed to eliminate the duplicated articles.

2.2. Study selection and data extraction

One reviewer screened all titles, abstracts and full texts. Eligibility criteria include observational studies using PSG or actigraphy in menopause without application of non-medical therapies, having cancer, using a ventilator or predict comorbidities.

Then the following information was extracted: (i) title, (ii) first author, (iii) year of publication (iv) country of study, (v) study design, (vi) sleep disorder, (vii) methods (viii) study population, and (ix) results.

3. Results

The results section includes the research strategy in a flowchart, studies characteristics, sleep disorders and outcomes.

3.1. Search results

The search identified 312 studies, of which 223 were excluded. The titles and abstracts of the remaining 89 articles were read and, after applying the inclusion and exclusion criteria, 31 were selected for full text. Of these, one with induced sleep, one that was predicted with a screening tool, two without PSG or actigraphy, and one comparing treatments were eliminated. Thus, a total of 26 published articles were included in this Scoping Review as shown in Figure 2.

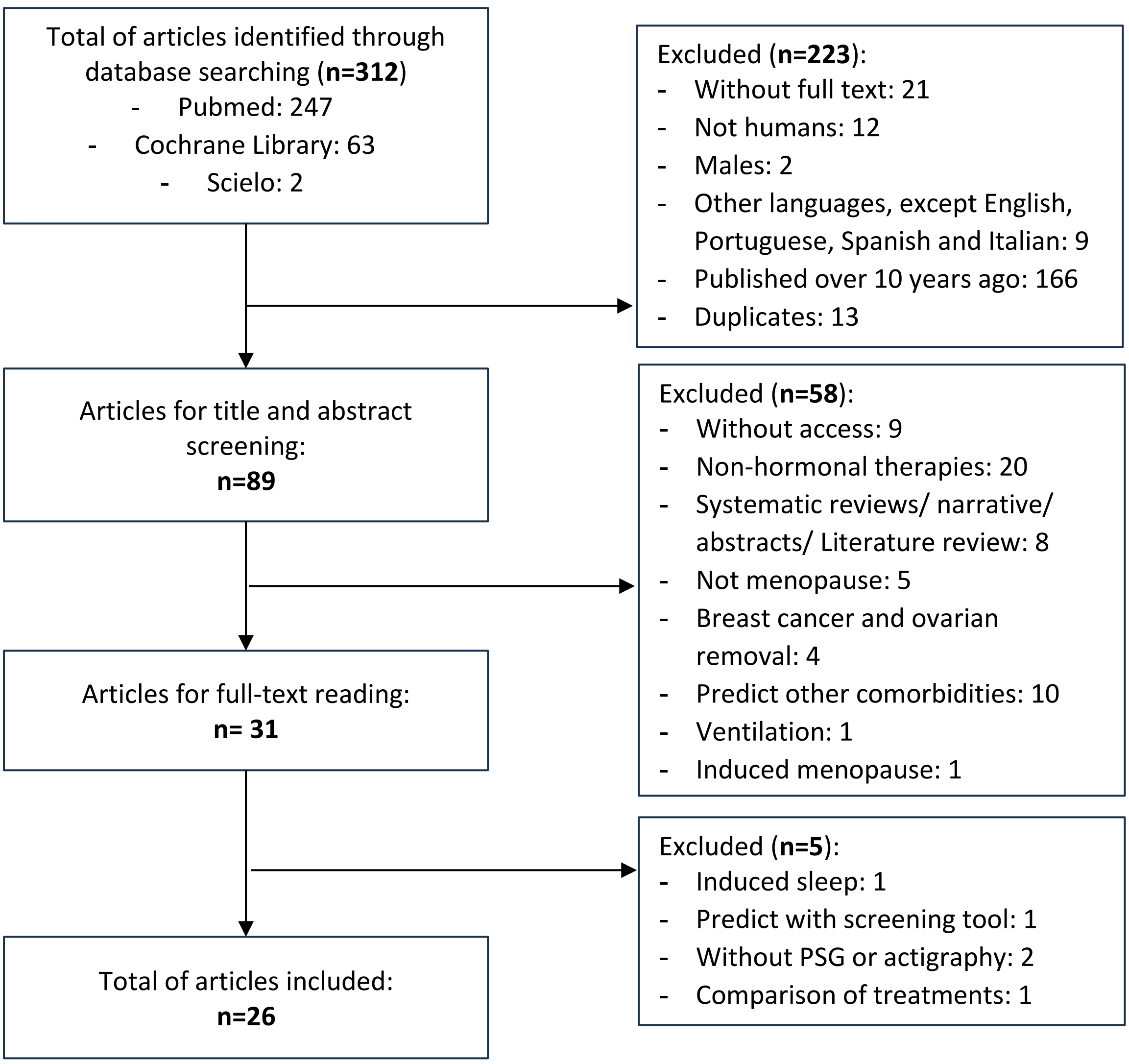

Figure 2 – Flowchart of systematic literature search

3.2. Characteristics of included studies

Table 1 – Sleep disorder and sample of each study

Article	*Sleep disorder*	*Sample, men/women*
BaHammam et al., 2016	OHS	48/ 96 (11 pre-. 85 postmenopause)
Baker et al., 2015	Insomnia	-/ 72 (47 early, 25 late menopause)
Coelho et al., 2022	OSA	-/ 70 (28 control group, 42 OSA)
Frange et al., 2017	Insomnia	-/ 57 postmenopause (11 control)
Galvan et al., 2017	OSA	-/ 30 peri-/postmenopause
Gómez-Santos et al., 2016	Sleep characteristics	-/ 177 (127 pre-, 50 postmenopause)
Hachul et al., 2021	Insomnia	-/ 550 (399 pre-, 211 postmenopause)
Heinzer, Petitpierre, et al., 2018	OSA	678/ 546 (90 pre-, 456 postmenopause)
Heinzer, Marti-Soler, et al., 2018	SDB	1024/ 1097 (769 postmenopause)
Kalleinen et al., 2021	Sleep architecture	-/ 57 premenopause
Lampio et al., 2017	Sleep architecture	-/ 60
Matthews et al., 2019	Sleep characteristics	-/1203 menopause
Matthews et al., 2020	Sleep characteristics	-/ 251
Matthews et al., 2021	Sleep characteristics	-/ 159 pre/early perimenopause
Mirer et al., 2015	SDB	-/ 228 menopause
Mirer et al., 2017	SDB	-/ 219 (14 pre, 94 peri, 83 post, 28 peri/post)
Mogavero et al., 2024	RLS	43/ 60
Naufel et al., 2018	Sleep architecture	-/ 53 menopause
Odai et al., 2022	OSAS	-/ 51 postmenopause
Polesel et al., 2015	OSAS	-/ 407 (268 pre-, 139 postmenopause)
Polesel et al., 2021	OSA	-/ 550 (334 pre-, 166 post menopause)
Toffol et al., 2021	Sleep architecture	-/ 35 (17 peri, 18 postmenopause)
Sahola et al., 2024	Sleep architecture	-/ 34
Virtanen et al., 2018	Sleep architecture	-/ 72 (17 peri, 44 postmenopause, 11 young)
Virtanen et al., 2023	Sleep architecture	-/ 32 (15 peri, 17 postmenopause)
Xu et al., 2015	OSAS	-/ 207 (67 pre, 140 postmenopause)

Legend: OHS – Obesity Hypoventilation Syndrome; OSA – Obstructive sleep apnea; OSAS – OSA Syndrome; SDB – Sleep-disordered breathing

Table 1 characterizes 13 cross-sectional studies, 11 cohort studies, 1 longitudinal study and 1 control study, of which investigated in the United States of America (USA) (BaHammam et al., 2016; Baker et al., 2015; Galvan et al., 2017; Matthews et al., 2019, 2020, 2021; Mirer et al., 2015, 2017), Brazil (Coelho et al., 2022; Frange et al., 2017; Hachul et al., 2021; Naufel et al., 2018; Polesel et al., 2015, 2021), Finland (Kalleinen et al., 2021; Lampio et al., 2017; Sahola et al., 2024; Toffol et al., 2021; Virtanen et al., 2018, 2023), Spain (Gómez-Santos et al., 2016), Switzerland (Heinzer, Marti-Soler, et al., 2018; Heinzer, Petitpierre, et al., 2018), Italy (Mogavero et al., 2024), Japan (Odai et al., 2022) and China (Xu et al., 2015).

In menopause, the sleep disorders studied are insomnia (Baker et al., 2015; Frange et al., 2017; Hachul et al., 2021), sleep architecture (Gómez-Santos et al., 2016; Kalleinen et al., 2021; Lampio et al., 2017; Matthews et al., 2019, 2020, 2021; Naufel et al., 2018; Sahola et al., 2024; Toffol et al., 2021; Virtanen et al., 2018, 2023), OSA (Coelho et al., 2022; Galvan et al., 2017; Heinzer, Petitpierre, et al., 2018; Polesel et al., 2021), OSAS (Odai et al., 2022; Polesel et al., 2015; Xu et al., 2015), obesity hypoventilation syndrome (OHSS) (BaHammam et al., 2016), sleep-disordered breathing (SDB) (Heinzer, Marti-Soler, et al., 2018; Mirer et al., 2015, 2017) and RLS (Mogavero et al., 2024).

3.3 Outcome of sleep disorders

Sleep architecture

Eleven articles studied sleep architecture as shown in Table 2. Gómez-Santos et al., 2016 compared premenopausal and postmenopausal women, finding a loss of circadian robustness and worsening sleep quality in postmenopausal women. Another paper (Virtanen et al., 2018) added a sample of young women, showing that this group had longer rapid eye movement (REM) latency, more slow wave sleep (SWS), less wakefulness after sleep onset (WASO), lower arousal index, higher total sleep time (TST), and higher sleep efficiency (SE) than the postmenopausal groups. Virtanen et al., 2023 presented the same results for menopausal women, adding a decrease in REM sleep. Hormone therapies showed less SWS in one article (Virtanen et al., 2018) and attenuation of sleep disturbances after 6 months of oral intake in another (Virtanen et al., 2023).

Three articles (Kalleinen et al., 2021; Lampio et al., 2017; Matthews et al., 2021) followed a sample of perimenopausal women and recorded postmenopausal changes after a few years. Two authors (Kalleinen et al., 2021; Lampio et al., 2017) found decreased sleep latency, increased deep sleep, and greater fragmentation. Lampio et al., 2017 also showed decreased TST and increased REM sleep latency. The third author (Matthews et al., 2021) found higher beta on non-REM (NREM) electroencephalogram (EEG) in the postmenopausal transition and that sleep duration, continuity, and depth were not related to the change in menopausal status.

Race/ethnicity at menopause has been studied with actigraphy, concluding longer sleep duration and lower WASO in White women (Matthews et al., 2019, 2020). In a 12-year follow-up, Black women also had longer sleep duration than Chinese women (Matthews et al., 2020). Another paper showed a higher WASO in Black people and Hispanics than in Japanese or Chinese (Matthews et al., 2019).

A study divided a sample of menopausal women into obese and non-obese (Naufel et al., 2018). Sleep efficiency, sleep latency, TST, WASO, and periodic limbs movement (PLMS) were similar between groups. However, obesity has been associated with difficulty reaching REM sleep. Waist circumference (WC) and waist-to-hip ratio (WHR) were correlated with WASO.

Sleep during menopause can be affected by hormone levels. Toffol et al., 2021 compared melatonin values, relating high values to better NREM sleep in perimenopausal women and more interrupted NREM and REM sleep in postmenopausal women. Sahola et al., 2024 focused on cortisol and presented poor sleep with higher cortisol levels during the day, while a worse SWS with a higher morning cortisol response. Kalleinen et al., 2021 found no follicle-stimulating hormone (S-FSH) correlations in women's sleep.

In PSG assessment, the Apnea-Hypopnea Index (AHI) and oxygen desaturation index (ODI) increased in postmenopausal women (Gómez-Santos et al., 2016; Kalleinen et al., 2021; Lampio et al., 2017), as did the respiratory disturbance index (RDI) in obese women (Naufel et al., 2018).

Table 2 – Outcomes related to sleep architecture

Article	***Outcome***
(Gómez-Santos et al., 2016)	Postmenopausal women exhibit a loss of circadian robustness, and a worsening of sleep quality compared with premenopausal women. Postmenopausal women had increased frequency of sleep related breathing with an increased RDI.
(Kalleinen et al., 2021)	A 10-year follow-up showed reduced sleep latency and an increase in proportion of deep sleep, frequency of awakenings/ arousals, AHI and ODI. These changes are not associated with alterations in S-FSH concentrations
(Lampio et al., 2017)	A 6-year follow-up presented shorter TST, lower sleep efficiency and SL in N1, greater sleep fragmentation, SL to REM, AHI and ODI.
(Matthews et al., 2019)	White postmenopausal women had longer sleep duration and lower WASO. Black people and Hispanics had higher WASO.
(Matthews et al., 2020)	In a 12-year follow-up, women experienced longer sleep duration and decreased WASO. Sleep duration increased more in blacks and whites.
(Matthews et al., 2021)	Levels of PSG-assessed NREM EEG beta were higher ate follow-up in midlife women who transitioned to postmenopausal. Sleep duration, continuity and depth were not related to change in menopausal status.
(Naufel et al., 2018)	Sleep efficiency, SL, TST, WASO and PLMS were similar between nonobese and obese participants. The obese group had higher RDI and AHI. Obesity is associated with difficulty reaching REM sleep. WC and WHR correlated with WASO.
(Toffol et al., 2021)	High melatonin levels were related to better NREM sleep in perimenopausal women, while in postmenopausal suggested more disrupted NREM and REM sleep (lower SWS percentage and more awakenings from REM sleep).
(Sahola et al., 2024)	Poor sleep (fewer REM periods and more WASO) was related to higher daytime cortisol levels, while worse SWS was associated with a greater morning cortisol response.
(Virtanen et al., 2018)	Young women had a longer REM latency, more SWS, less WASO, lower awakening index, longer TST and higher SE than the postmenopausal groups. Off-HT group had more SWS than the on-HT group.
(Virtanen et al., 2023)	During climacteric, TST, SE, SWS and REM sleep decreased, and WASO and awakenings increased. Six months of oral HT attenuate sleep disturbance.

Legend: AHI – apnea-hypopnea index; ODI – oxygen desaturation index; TST – total sleep time; SL – sleep latency; REM – rapid eye movement; WASO – wakefulness after sleep onset; PLMS – period limbs movement; RDI – respiratory disturbance index; WC – waist circumference; WHR – waist-hip ratio; SWS – slow wave sleep; SE – sleep efficiency; HT – hormonal therapy

Insomnia

Table 3 shows three studies related to insomnia. Women with no sleep complaints in their medical history developed insomnia at the onset of menopause, according to Baker et al., 2015. Severe sleep deficit with shorter sleep duration, more WASO, and lower sleep efficiency was present in menopausal women with insomnia compared with those without insomnia (Baker et al., 2015). Hachul et al., 2021 presented the same results when comparing menopausal and premenopausal women. Frange et al., 2017 add decreased REM sleep and PLMS, and increased NREM sleep stage N1 and AHI, compared with the control group.

Table 3 – Outcomes related to insomnia

Article	***Outcome***
(Baker et al., 2015)	Women in the approach to menopause, have shorter sleep duration, more WASO, and poorer SE compared to women in the menopause transition without insomnia. Hot flashes are more common in insomniacs and contribute to nocturnal awakenings. No significant relationships between FSH or estradiol levels and beta EEG power.
(Frange et al., 2017)	Insomnia affected climacteric symptoms and pain interference but not pain intensity in postmenopausal women. No changes in objective sleep pattern were found, although the entire sample had diminished SE and REM sleep, and augmented stage N1 NREM sleep, WASO and AHI. PLMS were reduced compared to the control.
(Hachul et al., 2021)	Hot flashes were more frequent among women in perimenopause and among those using HT, and they tended to decrease in later stages. PSG correlates of insomnia were more frequent in menopause. Hot flashes were more frequent among women with insomnia disorders and women with isolated insomnia symptoms.

Legend: AHI – apnea-hypopnea index; REM – rapid eye movement; WASO – wakefulness after sleep onset; PLMS – period limbs movemens; SE – sleep efficiency; HT – hormonal therapy

In transition to menopause, symptoms increase and their correlation with insomnia has been investigated. Hot flashes are more common in women with insomnia and women with isolated symptoms of insomnia (Baker et al., 2015; Hachul et al., 2021), causing more awakenings per hour (Baker et al., 2015). However, *Hachul et al.* point out that hot flashes are more frequent in perimenopausal women and in those using hormone therapy, with a decrease in more advanced stages (Hachul et al., 2021). Pain also interferes with insomnia, but not with pain intensity in postmenopause (Frange et al., 2017). *Hachul et al.* claimed that women in later stages of menopause are accustomed to sleep fragmentation and report it less (Hachul et al., 2021).

As in the article by Kalleinen et al., 2021, another study found no significant relationship between FSH and EEG beta power as well as estradiol levels (Baker et al., 2015).

Sleep-disordered breathing

Sleep-disordered breathing (SDB) is addressed in three articles shown in Table 4. Heinzer, Marti-Soler, et al., 2018 compared men, premenopausal and postmenopausal women, finding a higher prevalence of SDB in men than women, and in postmenopausal versus premenopausal women. Age, neck circumference (NC) and snoring were significantly associated with SDB in men and postmenopausal women, with women being older than men in the presence of significant sleep apnea. However, the association between AHI and metabolic syndrome was greater in postmenopausal women.

Table 4 – Outcomes related to sleep-disordered breathing

Article	***Outcome***
(Heinzer, Marti-Soler, et al., 2018)	The prevalence of SDB was higher in men than in women, and in postmenopausal versus premenopausal women. Menopausal women taking HT had slightly lower AHI than the other menopausal women. Age, neck circumference, and snoring were significantly associated with SDB in men and postmenopausal women.
(Mirer et al., 2015)	HT was negatively associated with SDB only until the Women's Health Initiative results were publicized. HT users had lower mean AHI before July 2002, but after July 2002, apnea-hypopnea index was similar between users and non-users.
(Mirer et al., 2017)	Transition from pre- to postmenopausal is associated with increased severity of SDB. Age, BMI, NC, and WC were also associated with higher AHI but not with menopausal status. Every additional year in menopause was associated with 4% higher AHI and 7% greater odds of having AHI of 15 or greater.

Legend: AHI – apnea-hypopnea index; HT – hormonal therapy; SDB – sleep-disordered breathing; BMI – body mass index; NC – neck circumference; WC – waist circumference

Another study showed an increase in AHI from premenopause to perimenopause and postmenopause, with the highest AHI from perimenopause to postmenopause. Age, Body

Mass Index (BMI), neck circumference, and waist circumference were associated with higher AHI, not explaining the association with menopausal stage. Furthermore, the longer participants had been in menopause, more severe was SDB. Each additional year in menopause was associated with a 4% higher AHI or 7% higher odds of having an AHI of 15 or more (Mirer et al., 2017).

In 2002, the Women's Health Initiative Study reported that hormone therapy increases the risk of heart disease, and as a result, many women discontinued therapy. Mirer et al., 2017, verified that hormone therapy users had lower mean apnea-hypopnea index before July 2002 and similar AHI in users and nonusers, after July 2022. Heinzer, Marti-Soler, et al., 2018) found that menopausal women with HT had a slightly lower AHI than other women without HT.

Obstructive sleep apnea

Obstructive sleep apnea (Table 5) was significantly more frequent in groups of postmenopausal women, at all degrees of severity (Polesel et al., 2021). Meanwhile, *Coelho et al., 2022* found more postmenopausal women in the mild OSA group (70.8% versus 29.2%) compared with the control group. *Galvan et al.* (Galvan et al., 2017) no differences between the groups with and without OSA in terms of menopausal status.

OSA can be positional and Heinzer, Petitpierre, et al., 2018 called positional OSA (POSA) if the ratio of supine/non-supine position ≥2 and exclusive OSA if in non-supine position. In postmenopausal women and men, low BMI was associated with POSA and low AHI with ePOSA. Statistically, there were no significant differences between the study groups (premenopausal, postmenopausal and men) in terms of BMI, WHR and NC.

Polesel et al., 2021 observed a significant association between WC in OSA in postmenopausal women and WTR in premenopausal women. One centimeter in WC is 5% more associated with mild to severe OSA, 18% more associated with moderate to severe OSA, and 6% more associated with severe OSA.

Table 5 – Outcomes related to obstructive sleep apnea

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Article	Outcome
(Coelho et al., 2022)	More postmenopausal women in the mild OSA group compared with the control, but without statistically significant relationship with FSD. Free testosterone was higher in postmenopausal women in the mild OSA group compared to the control group.
(Galvan et al., 2017)	Undiagnosed OSA occurs commonly in women with depression who are in the menopausal transition and early postmenopausal and suggest that lower levels of estradiol are associated with moderate-to-severe OSA in this population.
(Heinzer, Petitpierre, et al., 2018)	There were statistically significant differences between pre-, postmenopausal women and men in terms of BMI, WHR and NC, with men having the highest and premenauposal women the lowest values. In postmenopausal women, a lower BMI was associated with POSA and a lower AHI with ePOSA.
(Polesel et al., 2021)	The frequency of patients with OSA was significantly higher in the postmenopausal group, at all severity levels of OSA. WC was the factor with the greatest statistically significant association on the OSA in the postmenopausal group.

Legend: OSA – Obstructive Sleep Apnea; FSD – female sexual dysfunction; BMI – body mass index; WHR – waist-hip ratio; NC – neck circumference; POSA – positional obstructive sleep apnea; ePOSA – exclusive POSA; WC – waist circumference

Female sexual dysfunction had no significant relationship in the OSA groups (Coelho et al., 2022). Depression in the menopausal transition and early postmenopausal occurs frequently in undiagnosed OSA, suggesting low estradiol levels associated with moderate to severe OSA. However, estradiol has not been directly associated with OSA in postmenopausal women (Galvan et al., 2017). Total testosterone was higher in perimenopause in the mild OSA groups and free testosterone in postmenopausal (Coelho et al., 2022).

Obstructive sleep apnea syndrome

Obstructive sleep apnea syndrome is presented in three articles, addressing the association with symptoms, hormones, WC and hypertension (Table 6). Odai et al., 2022 concluded that a higher RDI was significantly associated with increased joint pain, but there were no differences in tiredness, mood, difficulty sleeping, joint pain, fatigue, illness frequency, and physical symptoms with the SpO2 groups. However, lower SpO2 was associated with increased fatigue in middle-aged and older women who had treatment-resistant sleep

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disorders.

Polesel et al., 2015 concluded that the diagnosis of OSAS is higher in postmenopausal. Lower progesterone levels, estradiol levels, mean SpO2 and minimum SpO2, and statistically higher luteinizing hormone (LH), FSH and AHI in the postmenopausal groups compared with the premenopausal groups. The WC results indicate that a 1 cm increase leads to a 5% increase in the probability of developing moderate to severe OSAS. Furthermore, 87.5 cm of WC has a maximum accuracy of 75.7% for classifying a woman with or without OSAS.

Xu et al., 2015 also showed that the postmenopausal group with OSAS had higher WC, in addition to being older and having higher AHI and ODI values than premenopausal women. The presence of hypertension was associated with increased age, WC and BMI in the premenopausal group and with increased NC, WC, BMI and AHI in the postmenopausal group. The prevalence of hypertension was higher in the group of postmenopausal women with OSAS and BMI and AHI were the most affecting factors.

Table 6 – Outcomes related to obstructive sleep apnea syndrome

Article	***Outcome***
(Odai et al., 2022)	A higher RDI was significantly associated with an increased severity in joint pain and a lower nadir SpO2 was associated with the severity of fatigability in postmenopausal women who had treatment-refractory insomnia.
(Polesel et al., 2015)	Diagnosis of severe OSAS is highest in late postmenopause. Mean SpO2 and minimal SpO2 were lower in the posmenopausal groups compared with the premenopausal group. WC and postmenopause stages are considered factors independently associated with OSAS.
(Xu et al., 2015)	Presence of hypertension was associated with an increased age, WC, and BMI in premenopausal women and an increased NC, WC, BMI, and AHI in postmenopausal women.

Legend: RDI – respiratory disturbance index; OSAS – obstructive sleep apnea syndrome; WC – waist circumference; BMI – body mass index; NC – neck circumference; AHI – apnea hypopnea index

Obesity hypoventilation syndrome

Only one author (BaHammam et al., 2016) evaluated the differences in clinical characteristics of women and men with obesity hypoventilation syndrome (OHS). The results concluded that it is more prevalent in women than in men and more prevalent in post-menopause than in pre-menopause. When comparing a group of men with identical age and BMI to a group of postmenopausal women, there was a significantly greater difference in postmenopausal women. HCO_3 levels and duration of $SpO_2<90\%$ were significantly associated with OHS.

Restless legs syndrome

(Mogavero et al., 2024) verified the hypothesis that in women with RLS different changes in periodic leg movements (PLMS) occur during the postmenopausal period. The results confirmed an increase in the PLMS with a decrease in LMs, but not statistically significant. PLMS can contribute to the disturbance of sleep patterns.

4. Discussion

This study is the first scoping review to investigate the impact of sleep disturbances on menopause, with twenty-six articles focusing on a variety of topics. The results are from the last 10 years, which implies greater attention to this issue and helps this group of women with their complaints.

During menopause, women experience disrupted sleep, such as difficulty falling asleep or waking up during the night (Australian Menopause Society, 2025). In a meta-analysis, 50% of postmenopausal women have disturbed sleep or a sleep disorder (Salari et al., 2023). In this scoping review, a loss of circadian robustness and worsening sleep quality were found in these women with an increase in wakefulness after sleep onset and arousal index, and a decrease in total sleep time and sleep efficiency (Gómez-Santos et al., 2016; Kalleinen et al., 2021; Lampio et al., 2017; Virtanen et al., 2018, 2023). One sleep disorder is insomnia, which has been shown to include shorter sleep duration, more wakefulness after sleep onset, and lower sleep efficiency (Baker et al., 2015; Hachul et al., 2021), as well as decreased REM sleep and increased NREM stage N1 sleep (Frange et al., 2017).

Sleep architecture may be affected by progesterone and estrogen levels, as estrogen regulates sleep cycles and low levels make it difficult to fall asleep or stay asleep (de Zambotti et al., 2015). Polesel et al., 2015 showed that progesterone and estrogen levels are lower in postmenopausal women than in premenopausal women. Similarly, high levels of luteinizing hormone and follicle-stimulating hormone which are associated with more awakenings (de Zambotti et al., 2015; Polesel et al., 2015). However, Baker and cowokers (Baker et al., 2015) found no association of FSH or estradiol in women's sleep.

The circadian rhythm is influenced by cortisol and melatonin levels. Cortisol peaks at 9 am and gradually decreases throughout the day with the inversely proportional stimulus of melatonin, making the sleep-wake cycle (Hall & Guyton, n.d.). In this review, high cortisol levels during the day are associated with poor sleep and a greater morning cortisol response to worse slow-wave sleep in postmenopausal women (Sahola et al., 2024). While high melatonin levels are related to better NREM sleep in premenopausal women and more interrupted NREM and REM sleep in postmenopausal women (Toffol et al., 2021). It should be considered that cortisol acts on the central nervous system and high levels create a condition of chronic stress that prevents the entry of REM sleep at the appropriate time (Hall & Guyton, n.d.).

Vasomotor symptoms such as hot flashes are common in menopause and disrupt sleep. It is known for vascular reactivity with prominent vasodilation and subsequent vasoconstriction, possibly triggered by falling estrogen levels (Archer et al., 2011; Australian Menopause Society, 2025; Gupta et al., 2006). During these studies, hot flashes were common in women with insomnia or women with isolated symptoms of insomnia (Baker et al., 2015; Hachul et al., 2021), causing more awakenings per hour (Australian Menopause Society, 2025; Baker et al., 2015). Another author noted that hot flashes are more frequent in premenopausal women and in those using hormone therapy, decreasing with more advanced stages (Hachul et al., 2021). In a 2011 overview, they concluded that hormone therapy led to a significant reduction in hot flashes, but placebo with a 50% improvement relies on individual subjective assessment to improve (Archer et al., 2011).

Sleep-disordered breathing is commonly associated with men, but this view is changing. Prevalence is higher in men than in women (24), and in postmenopausal versus premenopausal women (Heinzer, Marti-Soler, et al., 2018). Another author specifies that AHI is higher in the perimenopausal to postmenopausal transition versus other menopausal transitions. However, sleep-disordered breathing becomes more severe with age, as for each additional year in menopause the AHI is associated with a 4% increase and a 7% increase in the likelihood of having an AHI of 15 or greater (Mirer et al., 2017).

Sleep apnea can be affected by weight gain and progesterone levels. Progesterone affects muscle activity in the back of the throat and stimulates breathing. As it decreases in menopause, it can contribute to partial airway obstruction and reduced respiratory drive (Currie, 2024). In the case of obstructive sleep apnea was more frequent in the postmenopausal group (Coelho et al., 2022; Polesel et al., 2015, 2021) regardless of the degree of severity (Polesel et al., 2021), while a study comparing groups with and without obstructive sleep apnea found no differences according to menopausal status (Galvan et al., 2017). Positional obstructive sleep apnea was associated with lower body mass index and prevalence of non-supine obstructive sleep apnea with low AHI (Heinzer, Petitpierre, et al., 2018). This association with body mass index may be due to specific hormonal patterns of fat deposition; both men and women in menopause tend to have truncal obesity that may overcome the positional effect (Ley et al., 1992). For this reason, the most striking results were obtained with waist circumference, rather than with neck circumference or waist-to-hip ratio. Waist circumference has a significant relationship with obstructive sleep apnea in postmenopausal women. One centimeter in waist circumference is 5% more associated with mild to severe, 18% more associated with moderate to severe, and 6% more associated with severe obstructive sleep apnea (Polesel et al., 2021). Another author showed that an increase of 1 centimeter leads to a 5% increase in the probability of developing moderate to severe obstructive sleep apnea syndrome. Furthermore, 87.5 centimeter of waist circumference has a maximum accuracy of 75.7% to classify a woman with or without this syndrome (Polesel et al., 2015). One author (Mogavero et al., 2024) addressed obesity hypoventilation syndrome and found that it was more prevalent in women than in men and in postmenopausal women than in premenopausal women. When comparing a group of men age- and BMI-matched to a group of postmenopausal women, there was a significantly greater difference in postmenopausal women. HCO3 levels and duration of SpO2 >90% were significantly associated with OHSS.

The prevalence of sleep-disordered breathing increases in patients with metabolic comorbidities (Tandon et al., 2022). Postmenopausal women show an association between the apnea-hypopnea index and metabolic syndrome (Heinzer, Marti-Soler, et al., 2018). One of the risk factors, arterial hypertension, is related to increased age, waist circumference and body mass index in the premenopausal group and to increased neck circumference, waist circumference, body mass index and apnea-hypopnea index in the postmenopausal group (Xu et al., 2015). Other diseases may be associated with sleep apnea in these groups, due to decreased estrogen. In the case of sexual dysfunction, there is no relationship. However, depression in the menopause transition and early postmenopausal often occurs in undiagnosed obstructive sleep apnea (Coelho et al., 2022).

Restless legs syndrome is another condition that is more common in women. The included study found an increase in periodic leg movement with a decrease in leg movements, but this was not statistically significant (BaHammam et al., 2016).

A scoping study focusing on the impact of sleep disorders during menopause could help healthcare professionals pay more attention to the complaints of this group of people. It should be noted that hormone levels are a key factor. Specific analyses could lead to more appropriate treatment and, consequently, symptom relief. In the development of this framework, studies of other sleep disorders, such as restless legs syndrome, were lacking.

This study had some limitations, such as the fact that the search only included the last 10 years of observational studies and some languages. As a scoping review, the quality of the articles was not assessed, although systematic or narrative reviews were also not included.

5. Conclusion

In conclusion, this review revealed interest in the field of sleep for menopausal women. Sleep disorders in this group of women require that complaints be valued and evaluated appropriately. As hormonal fluctuations cause sleep and breathing disorders, appropriate treatment should be considered. Future studies should be conducted to address the lack of information on certain pathologies, such as Cheyne-Stokes respiration and central sleep apnea.

References

Archer, D. F., Sturdee, D. W., Baber, R., de Villiers, T. J., Pines, A., Freedman, R. R., Gompel, A., Hickey, M., Hunter, M. S., Lobo, R. A., Lumsden, M. A., MacLennan, A. H., Maki, P., Palacios, S., Shah, D., Villaseca, P., & Warren, M. (2011). Menopausal hot flushes and night sweats: where are we now? *Climacteric*, *14*(5), 515–528. https://doi.org/10.3109/13697137.2011.608596

Australian Menopause Society. (2025). *Menopause and Sleep*. https://www.menopause.org.au/hp/information-sheets/menopause-and-sleep

BaHammam, A. S., Pandi-Perumal, S. R., Piper, A., Bahammam, S. A., Almeneessier, A. S., Olaish, A. H., & Javaheri, S. (2016). Gender differences in patients with obesity hypoventilation syndrome. *Journal of Sleep Research*, *25*(4), 445–453. https://doi.org/10.1111/JSR.12400

Baker, F. C., Willoughby, A. R., Sassoon, S. A., Colrain, I. M., & de Zambotti, M. (2015). Insomnia in women approaching menopause: Beyond perception. *Psychoneuroendocrinology*, *60*, 96–104. https://doi.org/10.1016/J.PSYNEUEN.2015.06.005

Coelho, G., Bittencourt, L., Andersen, M. L., Guimarães, T. M., Silva, L. O. e., Luz, G. P., Tufik, S., & Hachul, H. (2022). Depression and obesity, but not mild obstructive sleep apnea, are associated factors for female sexual dysfunction. *Sleep and Breathing*, *26*(2), 697–705. https://doi.org/10.1007/s11325-021-02433-w

Currie, H. (2024). *Menopause and insomnia 2 of 3*. www.womens-health-concern.org

David, A., Moita, P. J., Reis, C., Pinto, P., Peralta, R., & Ferreira, D. (n.d.). *Porque o sono é importante para a saúde? Como a luz influencia o sono Tenho de me preocupar se ronco? 02 Dormir muito ou dormir bem?*

de Zambotti, M., Colrain, I. M., & Baker, F. C. (2015). Interaction between Reproductive Hormones and Physiological Sleep in Women. *The Journal of Clinical Endocrinology & Metabolism*, *100*(4), 1426–1433. https://doi.org/10.1210/jc.2014-3892

Frange, C., Naufel, M. F., Andersen, M. L., Ribeiro, E. B., Girão, M. J. B. C., Tufik, S., & Hachul, H. (2017). Impact of insomnia on pain in postmenopausal women. *Climacteric*, *20*(3), 262–267. https://doi.org/10.1080/13697137.2017.1309381

Galvan, T., Camuso, J., Sullivan, K., Kim, S., White, D., Redline, S., & Joffe, H. (2017). Association of estradiol with sleep apnea in depressed perimenopausal and postmenopausal women: A preliminary study. *Menopause*, *24*(1), 112–117. https://doi.org/10.1097/GME.0000000000000737

Gómez-Santos, C., Saura, C. B., Lucas, J. A. R., Castell, P., Madrid, J. A., & Garaulet, M. (2016). Menopause status is associated with circadian- and sleep-related alterations. *Menopause*, *23*(6), 682–690. https://doi.org/10.1097/GME.0000000000000612

Gupta, P., Sturdee, D. W., Palin, S. L., Majumder, K., Fear, R., Marshall, T., & Paterson, I. (2006). Menopausal symptoms in women treated for breast cancer: the prevalence and severity of symptoms and their perceived effects on quality of life. *Climacteric*, *9*(1), 49–58. https://doi.org/10.1080/13697130500487224

Hachul, H., Castro, L. S., Bezerra, A. G., Pires, G. N., Poyares, D., Andersen, M. L., Bittencourt, L. R., & Tufik, S. (2021). Hot flashes, insomnia, and the reproductive stages: a cross-sectional observation of women from the EPISONO study. *Journal of Clinical Sleep Medicine*, *17*(11), 2257–2267. https://doi.org/10.5664/JCSM.9432

Hall, J. E., & Guyton, A. C. (n.d.). *Guyton and Hall Textbook of Medical Physiology*.

Heinzer, R., Marti-Soler, H., Marques-Vidal, P., Tobback, N., Andries, D., Waeber, G., Preisig, M., Vollenweider, P., & Haba-Rubio, J. (2018). Impact of sex and menopausal status on the prevalence, clinical presentation, and comorbidities of sleep-disordered breathing. *Sleep Medicine*, *51*, 29–36. https://doi.org/10.1016/J.SLEEP.2018.04.016

Heinzer, R., Petitpierre, N. J., Marti-Soler, H., & Haba-Rubio, J. (2018). Prevalence and characteristics of positional sleep apnea in the HypnoLaus population-based cohort. *Sleep Medicine*, *48*, 157–162. https://doi.org/10.1016/j.sleep.2018.02.011

Kalleinen, N., Aittokallio, J., Lampio, L., Kaisti, M., Polo-Kantola, P., Polo, O., Heinonen, O. J., & Saaresranta, T. (2021). Sleep during menopausal transition: A 10-year follow-up. *Sleep*, *44*(6), 1–8. https://doi.org/10.1093/sleep/zsaa283

Lampio, L., Polo-Kantola, P., Himanen, S. L., Kurki, S., Huupponen, E., Engblom, J., Heinonen, O. J., Polo, O., & Saaresranta, T. (2017). Sleep during menopausal transition: A 6-year follow-up. *Sleep*, *40*(7). https://doi.org/10.1093/sleep/zsx090

Ley, C., Lees, B., & Stevenson, J. (1992). Sex- and menopause-associated changes in body-fat distribution. *The American Journal of Clinical Nutrition*, *55*(5), 950–954. https://doi.org/10.1093/ajcn/55.5.950

Matthews, K. A., Hall, M. H., Lee, L., Kravitz, H. M., Chang, Y., Appelhans, B. M., Swanson, L. M., Neal-Perry, G. S., & Joffe, H. (2019). Racial/ethnic disparities in women's sleep duration, continuity, and quality, and their statistical mediators: Study of women's health across the nation. *Sleep*, *42*(5). https://doi.org/10.1093/SLEEP/ZSZ042

Matthews, K. A., Kravitz, H. M., Lee, L., Harlow, S. D., Bromberger, J. T., Joffe, H., & Hall, M. H. (2020). Does midlife aging impact women's sleep duration, continuity, and timing?: A longitudinal analysis from the study of women's health across the nation. *Sleep*, *43*(4). https://doi.org/10.1093/SLEEP/ZSZ259

Matthews, K. A., Lee, L., Kravitz, H. M., Joffe, H., Neal-Perry, G., Swanson, L. M., Evans, M. A., & Hall, M. H. (2021). Influence of the menopausal transition on polysomnographic sleep characteristics: A longitudinal analysis. *Sleep*, *44*(11). https://doi.org/10.1093/SLEEP/ZSAB139

McEwen, B. S. (1999). The Molecular and Neuroanatomical Basis for Estrogen Effects in the Central Nervous System. *The Journal of Clinical Endocrinology & Metabolism*, *84*(6), 1790–1797. https://doi.org/10.1210/jcem.84.6.5761

Mirer, A. G., Peppard, P. E., Palta, M., Benca, R. M., Rasmuson, A., & Young, T. (2015). Menopausal hormone therapy and sleep-disordered breathing: Evidence for a healthy user bias. *Annals of Epidemiology*, *25*(10), 779-784.e1. https://doi.org/10.1016/j.annepidem.2015.07.004

Mirer, A. G., Young, T., Palta, M., Benca, R. M., Rasmuson, A., & Peppard, P. E. (2017). Sleep-disordered breathing and the menopausal transition among participants in the Sleep in Midlife Women Study. *Menopause*, *24*(2), 157–162. https://doi.org/10.1097/GME.0000000000000744

Mogavero, M. P., DelRosso, L. M., Lanza, G., Lanuzza, B., Bruni, O., Strambi, L. F., & Ferri, R. (2024). Changes in time structure of periodic leg movements during sleep in restless legs syndrome: Effects of sex and age. *Sleep Medicine*, *115*, 137–144. https://doi.org/10.1016/J.SLEEP.2024.01.024

Naufel, M. F., Frange, C., Andersen, M. L., Girão, M. J. B. C., Tufik, S., Beraldi Ribeiro, E., & Hachul, H. (2018). Association between obesity and sleep disorders in postmenopausal women. *Menopause*, *25*(2), 139–144. https://doi.org/10.1097/GME.0000000000000962

Odai, T., Terauchi, M., Umeki, H., Miyasaka, N., & Somekawa, Y. (2022). Sleep apnea in postmenopausal women is associated with joint pain severity and fatigability: a cross-sectional study. *Menopause*, *29*(6), 680–686. https://doi.org/10.1097/GME.0000000000001974

Polesel, D. N., Hirotsu, C., Nozoe, K. T., Boin, A. C., Bittencourt, L., Tufik, S., Andersen, M. L., & Hachul, H. (2015). Waist circumference and postmenopause stages as the main associated factors for sleep apnea in women: A cross-sectional population-based study. *Menopause*, *22*(8), 835–844. https://doi.org/10.1097/GME.0000000000000406

Polesel, D. N., Nozoe, K. T., Bittencourt, L., Tufik, S., Andersen, M. L., Fernandes, M. T. B., & Hachul, H. (2021). Waist-to-height ratio and waist circumference as the main measures to evaluate obstructive sleep apnea in the woman's reproductive life stages. *Women and Health*, *61*(3), 277–288. https://doi.org/10.1080/03630242.2020.1862386

Resmed. (2025). *Acerca de distúrbios respiratórios do sono*. Resmed. https://www.resmed.pt/profissionais/apneia-do-sono/apneia-do-sono-drs/#component_2

Rundo, J. V., & Downey, R. (2019). *Polysomnography* (pp. 381–392). https://doi.org/10.1016/B978-0-444-64032-1.00025-4

Sahola, N., Toffol, E., Kalleinen, N., & Polo-Kantola, P. (2024). Worse sleep architecture but not self-reported insomnia and sleepiness is associated with higher cortisol levels in menopausal women. *Maturitas*, *187*. https://doi.org/10.1016/j.maturitas.2024.108053

Salari, N., Hasheminezhad, R., Hosseinian-Far, A., Rasoulpoor, S., Assefi, M., Nankali, S., Nankali, A., & Mohammadi, M. (2023). Global prevalence of sleep disorders during menopause: a meta-analysis. *Sleep and Breathing*, *27*(5), 1883–1897. https://doi.org/10.1007/s11325-023-02793-5

Sateia, M. J. (2014). International Classification of Sleep Disorders-Third Edition. *Chest*, *146*(5), 1387–1394. https://doi.org/10.1378/chest.14-0970

Secção Portuguesa da Menopausa. (2021). *Consenso Nacional sobre MENOPAUSA*. https://spginecologia.pt/wp-content/uploads/2021/10/Consenso-Nacional-Menopausa-2021.pdf

SNS24. (2023, May 10). *Síndrome de apneia obstrutiva do sono*. SNS24. https://www.sns24.gov.pt/tema/doencas-respiratorias/sindrome-de-apneia-obstrutiva-do-sono/

Tandon, V., Sharma, S., Mahajan, A., Mahajan, A., & Tandon, A. (2022). Menopause and sleep disorders. In *Journal of Mid-Life Health* (Vol. 13, Issue 1, pp. 26–33). Wolters Kluwer Medknow Publications. https://doi.org/10.4103/jmh.jmh_18_22

Toffol, E., Kalleinen, N., Himanen, S. L., Partonen, T., Haukka, J., & Polo-Kantola, P. (2021). Nighttime melatonin secretion and sleep architecture: different associations in perimenopausal and postmenopausal women. *Sleep Medicine*, *81*, 52–61. https://doi.org/10.1016/j.sleep.2021.02.011

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. In *Annals of Internal Medicine* (Vol. 169, Issue 7, pp. 467–473). American College of Physicians. https://doi.org/10.7326/M18-0850

UCI Health. (n.d.). *Sleep-Related Movement Disorders* . UCI Health. Retrieved March 27, 2025, from https://www.ucihealth.org/medical-services/sleep-services/sleep-related-movement-disorders

Utian, W. H. (1999). The International Menopause menopause-related terminology definitions. *Climacteric*, *2*(4), 284–286. https://doi.org/10.3109/13697139909038088

Virtanen, I., Kalleinen, N., Urrila, A. S., & Polo-Kantola, P. (2018). First-Night Effect on Sleep in Different Female Reproductive States. *Behavioral Sleep Medicine*, *16*(5), 437–447. https://doi.org/10.1080/15402002.2016.1228646

Virtanen, I., Polo-Kantola, P., Turpeinen, U., Hämäläinen, E., & Kalleinen, N. (2023). Effect of external sleep disturbance on sleep architecture in perimenopausal and postmenopausal women. *Climacteric*, *26*(2), 103–109. https://doi.org/10.1080/13697137.2022.2158727

Wilson, A., & Attarian HP. (2016). *Clinical Handbook of Insomnia* (3rd ed.). Humana Press.

Xu, H. J., Lan, X. F., Li, Q. Y., Zhou, L. N., Zhang, X. J., Guo, Q., Ni, J. H., & Cao, B. (2015). Factors affecting blood pressure profile in pre and postmenopausal women with obstructive sleep apnea hypopnea syndrome. *Sleep and Breathing*, *19*(1), 169–174. https://doi.org/10.1007/S11325-014-0983-Z

Zolfaghari, S., Yao, C., Thompson, C., Gosselin, N., Desautels, A., Dang-Vu, T. T., Postuma, R. B., & Carrier, J. (2020). Effects of menopause on sleep quality and sleep disorders: Canadian Longitudinal Study on Aging. *Menopause*, *27*(3), 295–304. https://doi.org/10.1097/GME.0000000000001462