



# Global prevalence of sleep disorders during menopause: a meta-analysis

Nader Salari<sup>1</sup> · Razie Hasheminezhad<sup>2</sup> · Amin Hosseinian-Far<sup>3</sup> · Shabnam Rasoulpoor<sup>4</sup> · Marjan Assefi<sup>5</sup> · Sohila Nankali<sup>6</sup> · Anisodowleh Nankali<sup>7</sup> · Masoud Mohammadi<sup>8</sup> 

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## Abstract

**Background** Sleep disorders are conditions that have long-term effects on health, quality of sexual function, productivity at work, and overall quality of life. Considering that reports on menopausal sleep disorders are heterogeneous, the aim of this research was to determine the global prevalence of sleep disorders during menopause by meta-analysis.

**Methods** PubMed, Google Scholar, Scopus, WoS, ScienceDirect, and Embase databases were checked with suitable keywords. All screening stages of articles were reviewed based on PRISMA and their quality was determined based on STROBE. Data analysis, examination of heterogeneity, and publication bias of factors affecting heterogeneity were performed in CMA software.

**Results** The overall prevalence of sleep disorders among postmenopausal women was 51.6% (95% CI: 44.6–58.5%). The upper prevalence of sleep disorders was among postmenopausal women at 54.7% (95% CI: 47.2–62.1%). The upper prevalence of sleep disorders in the same population category was related to restless legs syndrome with a prevalence of 63.8% (95% CI: 10.6–96.3%).

**Conclusion** In this meta-analysis, sleep disorders during menopause were found to be common and significant. Therefore, it is recommended that health policymakers offer pertinent interventions in relation to the health and hygiene of sleep for women in menopause.

**Keywords** Sleep disorders · Menopause · Meta-analysis

✉ Masoud Mohammadi  
Masoud.mohammadi1989@yahoo.com

Nader Salari  
n\_s\_514@yahoo.com

Razie Hasheminezhad  
Ho.raziehasheminezhad@gmail.com

Amin Hosseinian-Far  
amin.hosseinianfar@northampton.ac.uk

Shabnam Rasoulpoor  
Sh.rasoulpur@gmail.com

Marjan Assefi  
Massefi@aggies.ncat.edu

Sohila Nankali  
drssoheilanankali98@gmail.com

Anisodowleh Nankali  
Anis\_nankali@yahoo.com

<sup>2</sup> Student Research Committee, Kermanshah University of Medical Sciences, Kermanshah, Iran

<sup>3</sup> Department of Business Systems & Operations, University of Northampton, Northampton, UK

<sup>4</sup> Department of Psychiatric Nursing, School of Nursing and Midwifery, Urmia University of Medical Sciences, Urmia, Iran

<sup>5</sup> Doctorate of Health Care Administration, University Of North Carolina, Greensboro, NC 27412, USA

<sup>6</sup> Department of Obstetrics and Gynecology, University of Northcentral, Scottsdale, AZ 85255, USA

<sup>7</sup> Department of Obstetrics and Gynecology, School of Medicine, Kermanshah University of Medical Sciences, Kermanshah, Iran

<sup>8</sup> Cellular and Molecular Research Center, Gerash University of Medical Sciences, Gerash, Iran

<sup>1</sup> Department of Biostatistics, School of Health, Kermanshah University of Medical Sciences, Kermanshah, Iran

## Introduction

Menopause is the complete cessation of menstruation and indicates the end of reproduction [1]. Menopause is a normal state in which symptoms are often well managed, but it can be debilitating for some women and therefore can be detrimental to their health [2–4]. A decrease in estrogen production and resulting increase in follicle-stimulating hormone cause follicular atrophy which is the main cause of menopause [4]. Sleep is a complex process with the brain in an active state of anesthesia [5]. Sleep disorders are determined by tools such as self-report questionnaires, polysomnography, and actigraphy [6, 7]. Irregular sleep and daytime sleepiness are common among the general public and are among the most important examples of sleep disorders and resulting symptoms [5–7].

Reports of sleep disorders vary greatly and prevalence has been reported to be between 12 and 79% among women [7, 8]. Sleep disorders have many negative effects on health. These include increased risk of chronic diseases, decreased daily functioning, decreased mood, reduced use of healthcare, and female sexual dysfunction [9–11].

About a third of women's lives around the world are affected by sleep and menopause, and both of these have a large effect on health [12]. Disturbance in falling asleep, disturbance in staying awake during the day and during work activities, and disturbance in the circadian rhythm are indicators that can help in diagnosis [13].

Studies that have examined the symptoms of postmenopausal women report that most of these women have obstructive sleep apnea [13]. In premenopause ages, the prevalence of such sleep disorders approximates 42%, in perimenopause ages 47%, and in postmenopause ages 60% [13–16]. Given the increasing number of postmenopausal women, as well as the importance of sleep quality in these individuals, the aim of this study was to perform a meta-analysis on sleep disorders during menopause in order to guide health professionals and experts in this field.

## Methods

The initial search was conducted in February 2022 and last updated in April 2022. To find relevant articles, the Embase, ScienceDirect, Scopus, WoS, PubMed, and Google Scholar databases were checked.

The keywords examined in order to search in the reported databases included: Sleep Disturbance, Sleep Problems, Sleep Deprivation, Sleep Disorders, Sleep, Menopause, Long Sleeper Syndrome, Restless Leg

Syndrome, Short Sleeper Syndrome, Sleep Wake Disorders, Obstructive Sleep Apnea.

### Studies included in the review

Observational studies that reported prevalence of sleep disorders, articles written in English, and also, articles with English abstracts translated for non-English speakers.

### Studies not included in the review

Studies whose full text was unavailable, case reports, interventional studies.

### The method of selecting and extracting studies in the systematic review

Studies were reviewed based on the inclusion and exclusion criteria and irrelevant items were removed. Data were entered into EndNote software in order to remove duplicate articles. All review steps were performed by three reviewers independently in order to avoid mistakes in reviewing studies and extracting data. All stages of reviewing articles followed PRISMA guidelines [14].

### Determining the quality of articles and statistical analysis of meta-analysis

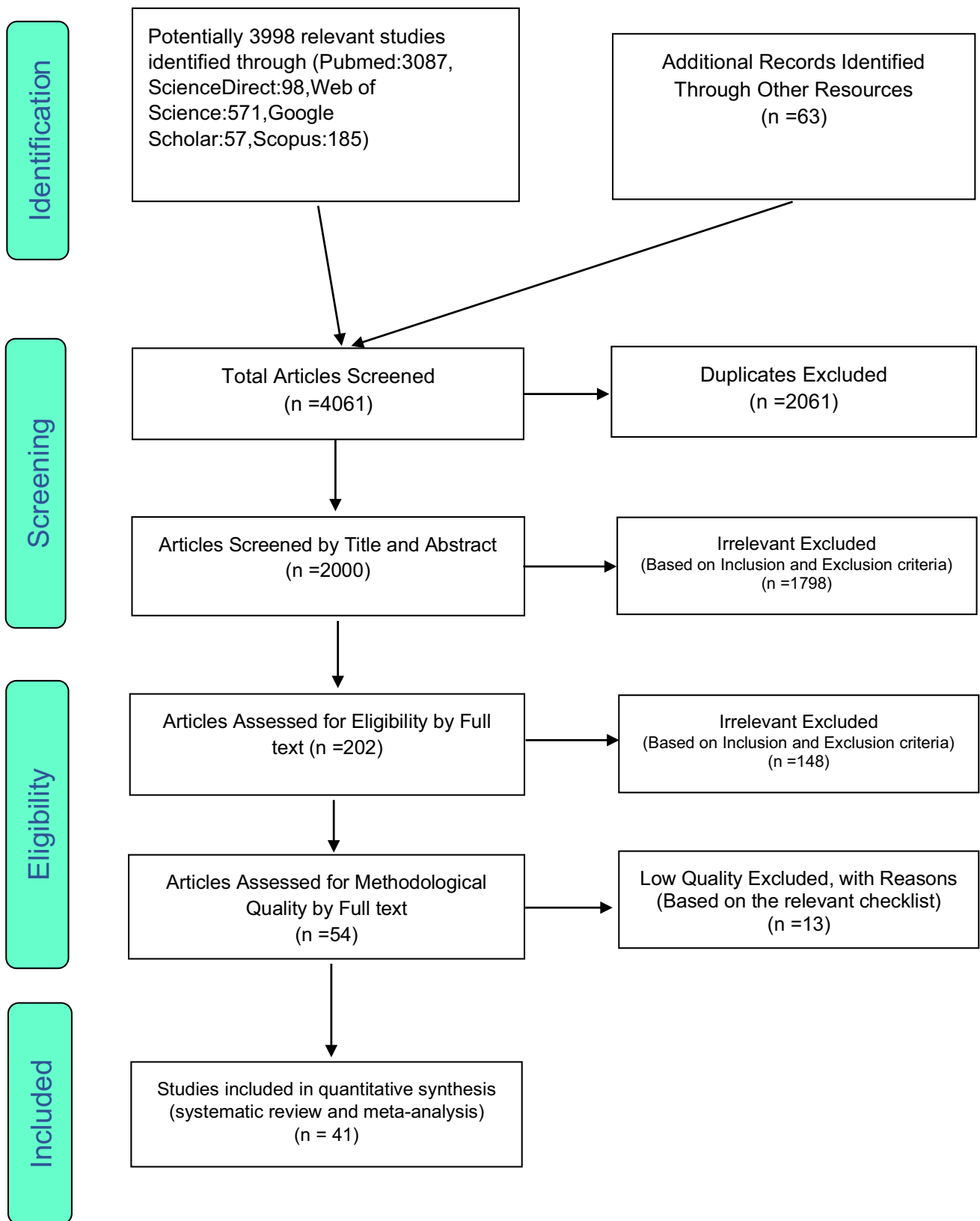
The STROBE checklist was used to check the quality of observational studies [15]. Based on the scores reported in STROBE, those studies with scores above 16 were considered high-quality articles. The extracted information was entered into the Comprehensive Meta-Analysis software and publication bias was checked with funnel plot and heterogeneity was checked with the  $I^2$  test.

## Results

A total of 3998 articles were identified within the searched databases and 63 articles were identified through a manual search. After exclusions, 41 studies remained for the meta-analysis. The studies were identified after following the four steps of the PRISMA guidelines (Fig. 1). The information in these articles is listed in Table 1.

The prevalence of sleep disorders among postmenopausal women was 51.6% (95% CI: 44.6–58.5%) (Fig. 2). Heterogeneity of studies ( $I^2$ : 98.4) and publication bias in studies were not significant ( $p$ : 0.596) (Fig. 3).

The meta-regression test showed that the larger the sample in the studies, the lower the overall prevalence of sleep



**Fig. 1** The process of reviewing, screening, and determining the final articles based on the PRISMA process

**Table 1** Information extracted from final studies

Author	Year	Country	Age	Instrument	Sample size	Prevalence of sleep disorder
Bairy et al. [17]	2009	India	48.7	MENQOL <sup>1</sup>	All: 352 Postmenopause: 352	Difficulty in sleeping in postmenopause: 51.7%
Fallahzadeh [18]	2007	Iran	47.4	Structured questionnaire	All: 346 Postmenopause: 346	Difficulties sleeping in postmenopause: 54.3%
Mondi Farsani et al. [4]	2019	Iran	51.7 ± 3.5	ISI <sup>2</sup> , PSQI <sup>3</sup>	All: 181 Menopause: 181	Poor sleep quality in all: 51.4% insomnia in menopause: 48%
Rahman et al. [19]	2011	Oman	Premenopause: 45.1 ± 4.9 Perimenopause: 46.4 ± 5.4 Postmenopause: 52.8 ± 6.4	MRS <sup>4</sup>	All: 3929 Pre: 190 Peri: 73 Post: 202	Sleeping problems In all: 43.20% Sleeping problems In premenopause: 33.7% Sleeping problems In perimenopause: 38.40% Sleeping problems In postmenopause: 52.20%
Mohamed et al. [20]	2010	Pakistan	49.4 ± 7.2	MRS	All: 3011 Pre-menopause: 641	Sleep problems in pre-menopause: 80%
Fallahzadeh [18]	2009	Sri Lankan	52.3 ± 4.7	MRS	All: 683 Pre-menopause: 144 Perimenopause: 132 Postmenopause: 405	Sleep problems in pre-menopause: 25.7% Sleep problems in perimenopause: 31.1% Sleep problems in post-menopause: 39.6%
Waidyasekera et al. [21]	2010	Kuching, Sarawak, Malaysia	45.0 ± 1.3	MRS	All: 356 Pre-menopause: 82 Perimenopause: 141 Postmenopause: 133	Sleep problems in all: 52.20% Sleep problems in pre-menopause: 29.20% Sleep problems in perimenopause: 66.70% Sleep problems in post-menopause: 51.1%
Farsani et al. [22]	2014	China	Premenopause: 36.9 ± 7.3 Postmenopause: 59.2 ± 7.0	PSQI <sup>5</sup>	All: 1088 Pre-menopause: 735 Postmenopause: 353	Poor sleeper in premenopause: 60.8% Poor sleeper in postmenopause: 73.1%
Rahman et al. [23]	2008	Finland	Premenopause: 47.7 ± 2.3 Postmenopause: 63.3 ± 3.6	BNSQ <sup>6</sup>	All: 59 Pre-menopause: 21 Postmenopause: 20	Sleep efficiency in pre-menopause: 84.3% Sleep efficiency in post-menopause: 80.20%

**Table 1** (continued)

Author	Year	Country	Age	Instrument	Sample size	Prevalence of sleep disorder
Dhillon et al. [24]	2009	Spanish	7.1±57.9	KI <sup>7</sup>	All: 10,514 Perimenopause: 3298 Postmenopause: 7216	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Hilditch et al. [25]	2014	China	51.7±6.5	PSQI <sup>8</sup> , KI	All: 2046 Premenopause: 930 Perimenopause: 141 Postmenopause: 975	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Kalleinen et al. [26]	2012	Latin America	47.8± 5.9	MRS	All: 8373 Perimenopause: 916	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Blümel et al. [27]	2019	Dharwad and Bagalkote/India	40.3 to 48.8	The self-structured questionnaire/MRS	All: 9512 Postmenopause: 480	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Pedro et al. [28]	2006	Malaysia	57.1 ± 6.6	Semi-structured questionnaire	All: 326 Postmenopause: 326	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Resta et al. [29]	2006	Brazil	7.7±5.5	ESS <sup>9</sup>	All: 38 Postmenopause: 38	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Blümel et al. [30]	2014	India	49.1	Questionnaire	All: 252 Postmenopause: 252	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Matsumoto et al. [31]	2003	Italian	14.7±41.3	Sleep and Healthy Questionnaire, ESS	All: 230 Premenopause: 89 Postmenopause: 59	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Singh and Pradhan [32]	2006	Finland	Premenopause: 46.2 Postmenopause: 62.5	Basic Nordic Sleep Questionnaire, HI <sup>10</sup>	All: 393 Premenopause: 131 Postmenopause: 262	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%
Anttalainen et al. [33]	2001	Toronto	< 45 years and > 55 years	AHI <sup>11</sup>	All: 1315 Premenopause: 797 Postmenopause: 518	Sleep problems in all: 45.7% Sleep problems in perimenopause: 37.5% Sleep problems in postmenopause: 49.40% Sleep disturbance in all: 33.2% Sleep disturbance in premenopause: 24.8% Sleep disturbance in perimenopause: 34.8% Sleep disturbance in postmenopause: 40.9% Poor sleep quality in all: 46.25 Poor sleep quality in perimenopause: 43.7% Insomnia in all: 43.6% Insomnia in perimenopause: 41.7%

Table 1 (continued)

Author	Year	Country	Age	Instrument	Sample size	Prevalence of sleep disorder
Adimi Naghan et al. [3]	2020	Iran	60.4 ± 8.8	General Health Questionnaire-15 <sup>12</sup> , STOPBANG <sup>13</sup>	All: 4021 Postmenopause: 174	Insomnia in postmenopausal: 13.2%
Hachul de Campos et al. [34]	2020	Egypt	16.0±47.9	ESS, STOP-Bang questionnaire	All: 60 Pre-menopause: 27 Postmenopause: 33	RLS in premenopause: 81% RLS in postmenopause: 87.9%
Dancey et al. [35]	2018	Iran	57.0 ± 9.4	RLS Scale <sup>14</sup>	All: 980 Postmenopause: 980	RLS in postmenopause: 16.02%
Bagheri et al. [36]	2021	China	46.9	KMI <sup>15</sup>	All: 6745 Menopause: 1227	Insomnia in all: 44.7% Insomnia in menopause: 48%
Wang et al. [37]	2005	Korean	Premenopause: 43.8±3.5 Perimenopause: 45.7±4.8 Postmenopause: 56.0±7.4	DIS <sup>16</sup> , DMS <sup>17</sup> , EMA <sup>18</sup>	All: 2400 Pre-menopause: 926 Perimenopause: 402 Postmenopause: 1072	Insomnia in all: 9.7% Insomnia in premenopause: 7.3% Insomnia in perimenopause: 15.9% Insomnia in postmenopause: 19.7% Early morning awakening in premenopause: 3% Early morning awakening in perimenopause: 7.2% Early morning awakening in postmenopause: 11.5%
Shin et al. [38]	2008	China	48.9	Self-reported menopausal symptoms	All: 9557 Pre-menopause: 3286 Perimenopause: 2307 Postmenopause: 3964	Insomnia in all: 37.2% Insomnia in premenopause: 26.8% Insomnia in perimenopause: 42.7% Insomnia in postmenopause: 42.6%
Kapur et al. [39]	2006	China	Premenopause: 47.8 Perimenopause: 49.7 Postmenopause: 52.7	GCS <sup>19</sup>	All: 305 Pre-menopause: 103 Perimenopause: 100 Postmenopause: 102	Insomnia in all: 12.8% Insomnia in premenopause: 2.9% Insomnia in perimenopause: 21% Insomnia in postmenopause: 14.7% Troubled sleeping due to waking up in the middle of the night or early morning in premenopause: 4.9% Troubled sleeping due to waking up in the middle of the night or early morning in perimenopause: 19% Troubled sleeping due to waking up in the middle of the night or early morning in postmenopause: 15.75%

**Table 1** (continued)

Author	Year	Country	Age	Instrument	Sample size	Prevalence of sleep disorder
Yang et al. [40]	2006	California	Premenopause: 43.4 ± 5.3 Perimenopause: 53.0 ± 4.8 Postmenopause: 60.5 ± 3.4	Sleep-EVAL	All: 3243 Premenopause: 562 Perimenopause: 219 Postmenopause: 201	Insomnia in premenopause: 36.5% Insomnia in perimenopause: 56.6% Insomnia in postmenopause: 50.7% Insomnia in all: 54.5% Insomnia in premenopause: 40.6% Insomnia in perimenopause: 55.9% Insomnia in postmenopause: 61.1%
Fallahzadeh [18]	2003	Brazil	45–60	Structured pretested questionnaire	All: 367 Premenopause: 101 Perimenopause: 68 Postmenopause: 198	Insomnia in all: 54.5% Insomnia in premenopause: 40.6% Insomnia in perimenopause: 55.9% Insomnia in postmenopause: 61.1%
Kravitz et al. [41]	2008	Japan	Mailed to all 50-year-old	Self-administered questionnaire, MI <sup>20</sup>	All: 1169 Premenopause: 702 Perimenopause: 269 Postmenopause: 269	Insomnia in all: 54.5% Insomnia in premenopause: 31.8% Insomnia in perimenopause: 45% Insomnia in postmenopause: 44.6%
Ohayon [42]	2017	China	Perimenopause: 48.6 ± 5.5 Postmenopause: 53.0 ± 5.4	KMI	All: 1225 Perimenopause: 868 Postmenopause: 357	Insomnia in all: 69.39% Insomnia in perimenopause: 65.86% Insomnia in postmenopause: 77.87%
Ruan et al. [43]	1995	California	74 ± 9.3	RBS <sup>21</sup>	All: 589 Postmenopause: 589	Insomnia in postmenopause: 28.1%
von Mühlen et al. [44]	2008	China	Premenopause: 46.0 ± 2.5 Perimenopause: 48.1 ± 3.1 Postmenopause: 52.0 ± 3.7	Self-reported sleep problems	All: 1113 Premenopause: 433 Perimenopause: 319 Postmenopause: 361	Difficulty initiating sleep in premenopause: 12.3% Difficulty initiating sleep in perimenopause: 20.1% Difficulty initiating sleep in postmenopause: 27.1% Early morning awakenings in premenopause: 2.1% Early morning awakenings in perimenopause: 4.7% Early morning awakenings sleep in postmenopause: 5.9%

Table 1 (continued)

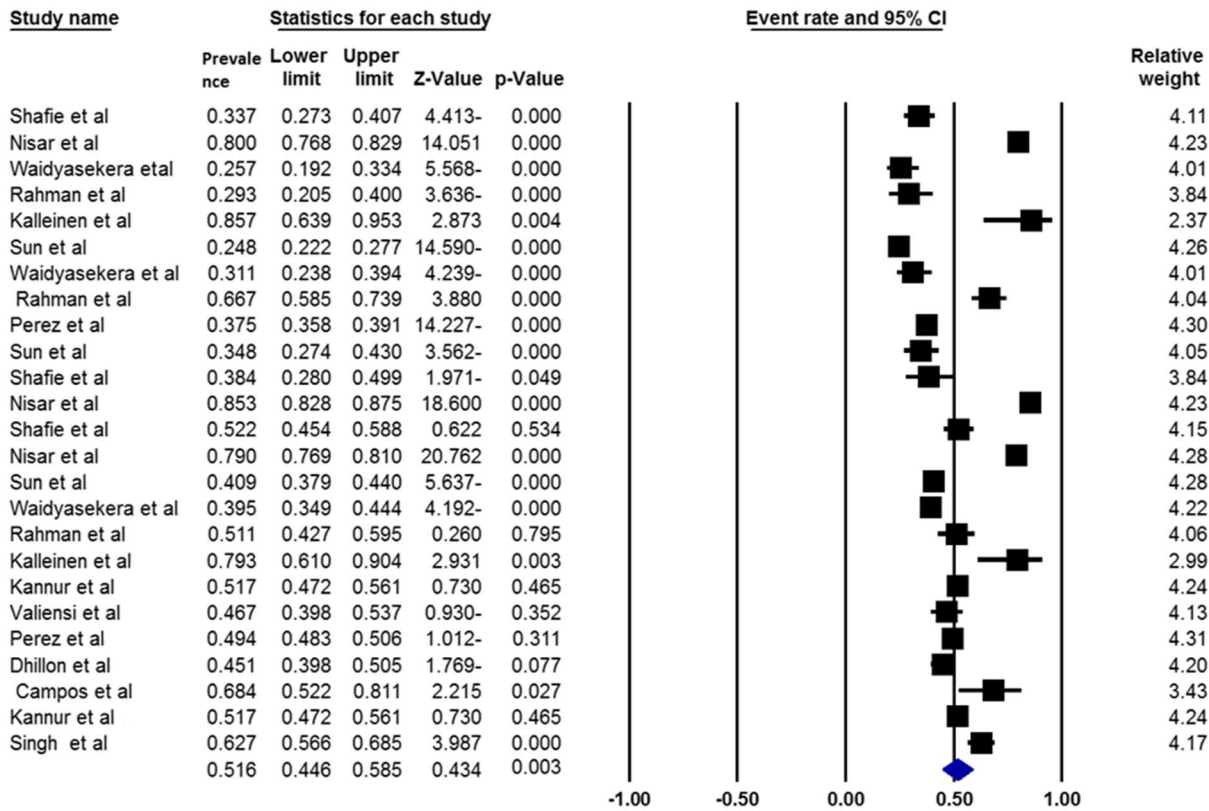
Author	Year	Country	Age	Instrument	Sample size	Prevalence of sleep disorder
Huang et al. [45]	2018	Japan	Premenopause: 43.7 ± 5.1 Postmenopause: 63.8 ± 7.6	ESS, Poor quality, Excessive daytime sleepiness, PSQI	All: 7713 Pre-menopause: Perimenopause: Postmenopause:	Sleep apnea in premenopause: 0 Sleep apnea in premenopause: 1.2%
Chang et al. [46]	1999	China	Premenopause: 47.3 Perimenopause: 49.3 Postmenopause: 51.6	Standardized questionnaire	All: 1900 Pre-menopause: 1258 Perimenopause: 92 Postmenopause: 540	Trouble sleeping in all: 20.79% Trouble sleeping in premenopause: 20.99% Trouble sleeping in perimenopause: 20.65% Trouble sleeping in postmenopause: 20.36%
Kannur et al. [47]	2003	Caucasian, African American, Chinese, Japanese, and Hispanic	Premenopause: 30.1	Self-reported sleep difficulty	All: 12,603 Pre-menopause: 4425	Sleep difficulty in premenopause: 31.40% Sleep difficulty in premenopause: 31.4%
Sun et al. [48]	2009	Indian	51.8 ± 5.8	GCS <sup>22</sup>	All: 129 Pre-menopause: 70	Sleep difficulty in premenopause: 20%
Bairy et al. [17]	1999	Canada	58.0 ± 5.0	MENQL <sup>23</sup>	All: 282 Postmenopause: 282	Difficulty falling asleep in postmenopause: 52%
Ho et al. [49]	2002	India	Premenopause: 46.6 Postmenopause: 45.4	SDQ-9 <sup>24</sup>	All: 200 Pre-menopause: 100 Postmenopause: 100	Sleepless in premenopause: 25% Sleepless in postmenopause: 34% Waking up at night in premenopause: 23% Waking up at night in postmenopause: 34%
Aaron et al. [50]	1981	Indian	40–55	Symptom checklist was prepared mainly based on Neugarten and Kraines'	All: 405 Pre-menopause: 135 Perimenopause: 135 Postmenopause: 135	Sleepless in premenopause: 54% Sleepless in premenopause: 67% Sleepless in postmenopause: 64%
Sharma et al. [51]	2003	Brazil	53–54	ESS <sup>25</sup>	All: 1180 Pre-menopause: 240 Postmenopause: 471	Often daytime sleepiness in premenopause: 2.1% Often daytime sleepiness in postmenopause: 1.9%



**Table 1** (continued)

Author	Year	Country	Age	Instrument	Sample size	Prevalence of sleep disorder
Valiensi et al. [16]	2019	Argentina	54.6±4.4	PSQI <sup>26</sup> , ESS <sup>27</sup> , Oviedo Sleep Questionnaire, DSM-IV <sup>28</sup>	All: 195 Postmenopause: 195	Insomnia in postmenopause: 15% Sleep apnea: 10% Sleep problems in postmenopause: 46.70%

<sup>1</sup>Menopause-Specific Quality of Life<sup>2</sup>Insomnia Severity Index<sup>3</sup>Pittsburgh Sleep Quality Index<sup>4</sup>Menopause Rating Scale<sup>5</sup>Pittsburgh Sleep Quality Index<sup>6</sup>Basic Nordic Sleep Questionnaire<sup>7</sup>Kupperman Index<sup>8</sup>The Pittsburgh Sleep Quality Index<sup>9</sup>Epworth Sleepiness Scale<sup>10</sup>Apnea Hypopnea Index<sup>11</sup>Apnea Hypopnea Index<sup>12</sup>Insomnia Screening Questionnaire<sup>13</sup>Snoring, tiredness, obstruction during sleep, hypertension, body mass index (BMI), neck circumference, age, and gender<sup>14</sup>Restless Legs Syndrome Scale<sup>15</sup>Kupperman Menopausal Index<sup>16</sup>Difficulty initiating sleep<sup>17</sup>Difficulty maintaining sleep<sup>18</sup>Early morning awakening<sup>19</sup>(KI)<sup>20</sup>Simplified menopause index<sup>21</sup>Rancho Bernardo Scale<sup>22</sup>Greene Climacteric Scale<sup>23</sup>Menopause-Specific Quality of Life<sup>24</sup>Strengths and Difficulties Questionnaire-9<sup>25</sup>Epworth Sleepiness Scale<sup>26</sup>Pittsburgh Sleep Quality Index<sup>27</sup>Epworth Sleepiness Scale<sup>28</sup>Diagnostic and Statistical Manual of Mental Disorders



Meta Analysis

Fig. 2 The overall prevalence of sleep disorders among postmenopausal women

disorders in postmenopausal women. (Fig. 4). Also, with the upward and increasing trend of studies until 2020 (Fig. 5), the sleep disorders among postmenopausal women have decreased ( $p < 0.05$ ).

Based on the subgroup analysis results reported in Table 2, the highest sleep disorder among postmenopausal women was 54.7% (95% CI: 47.2–62.1%) (Table 2).

Based on the subgroup analysis results reported in Table 3, the highest sleep disorders among postmenopausal women were related to restless legs syndrome (RLS) with 63.8% (95% CI: 10.6–96.3%) (Table 3).

Based on Table 4, it was found that for sleep apnea, the highest prevalence was related to postmenopause with a prevalence of 35.2% (95% CI: 12.9–66.5%); for RLS, the highest prevalence was related to postmenopause with a prevalence of 53.1% (95% CI: 3.1–97.6%); for insomnia, the highest prevalence is related to perimenopause with a prevalence of 37.6% (95% CI: 28.5–47.7%); for sleepiness, the highest prevalence was in postmenopause with a prevalence of 34.2% (95% CI: 8.5–74.5%); and for wake disorders,

the highest prevalence was in postmenopause with 14.2% (95% CI: 7.1–26.4%) (Table 4).

Discussion

Based on the results of the analysis, the overall prevalence of sleep disorders in all studies was 51.6%. Shafie et al. reported the sleep disorders during postmenopause were 52.2%, in perimenopause 38.4%, and in premenopause 33.7%. These results show that the prevalence of sleep disorders during postmenopause is higher than that in the premenopause and perimenopause stages [19]. Additionally, in a study by Waidyasekera et al., sleep disorders were reported to be 39.6% in the postmenopause stage, 31.1% in perimenopause, and 25.7% among women in the premenopause period [52]. A study by Castro et al. in 2021 in Colombia and during the coronavirus outbreak reported that the sleep disorder was 65.1% in the postmenopause and 54.5% in the premenopause stage [53].

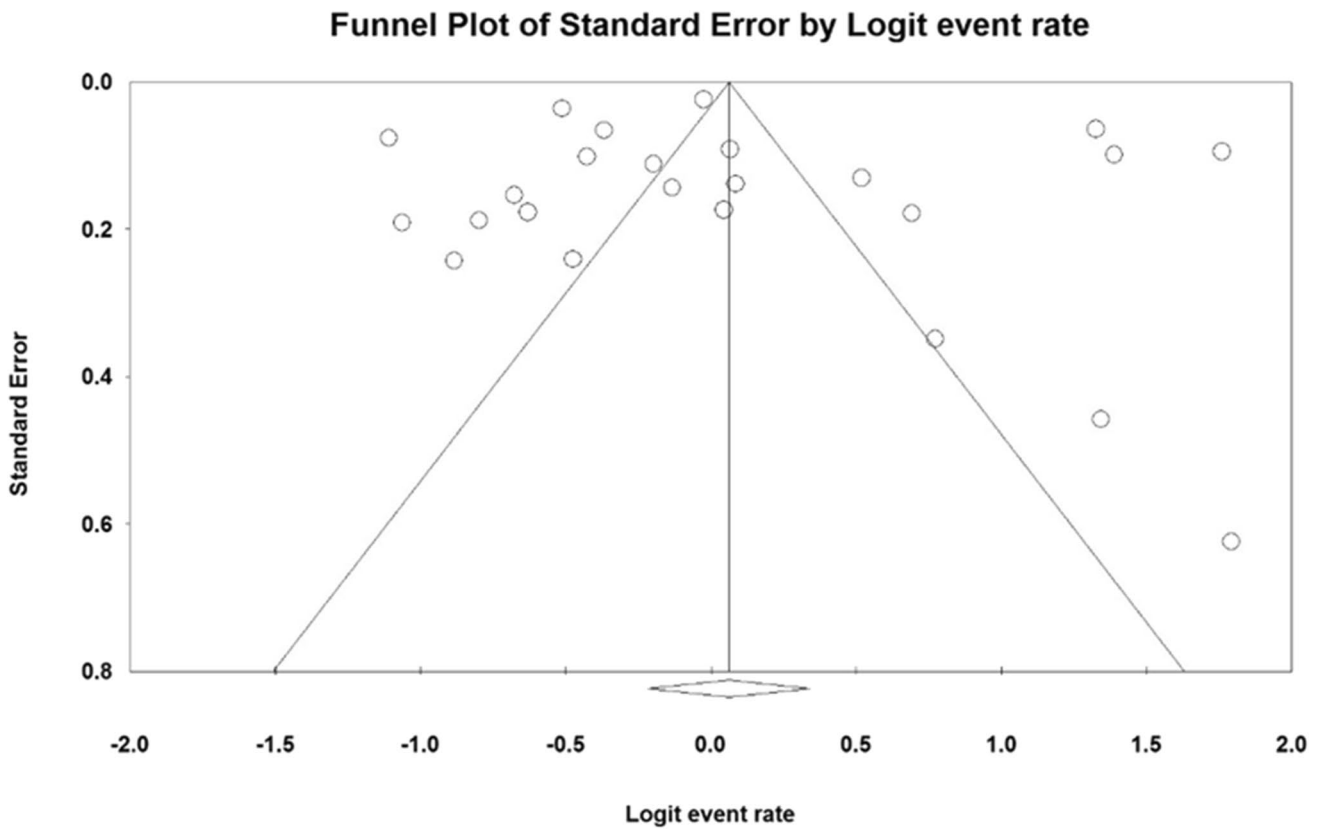
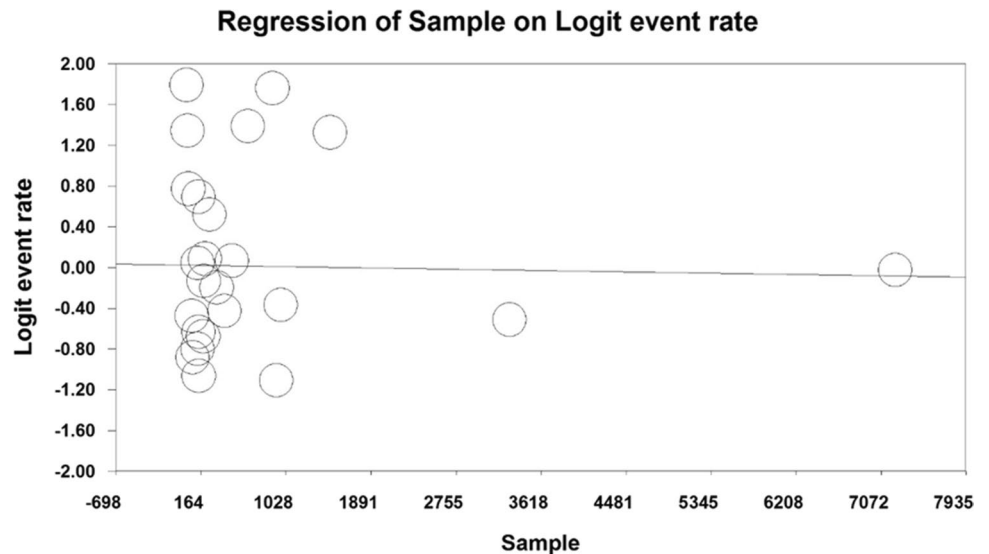


Fig. 3 Funnel plot to investigate the publication bias in studies

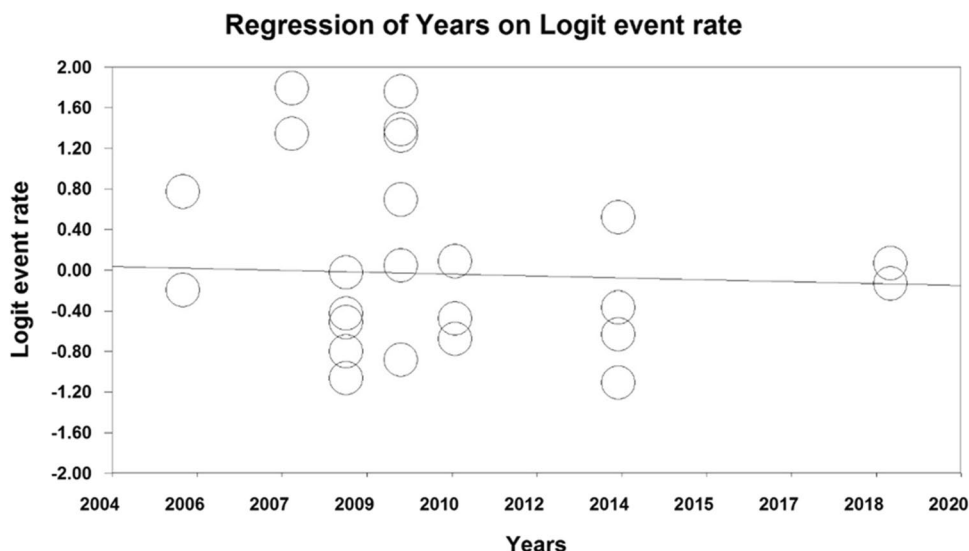
Studies have shown that 47 to 67% of postmenopausal women have OSA [54, 55]. The combination of factors such as weight gain and increase in BMI index as well as an increase in waist-to-hip ratio after menopause leads to changes in the upper airway and causes obstructive sleep

apnea and sleep disorders [1, 56]. Dancy et al. reported the prevalence of apnea among women based on menopausal stages to be 47% in postmenopause, yet with a lower prevalence of 21% at the premenopause stage [33]. The study by Heinzer reported the prevalence of OSA at the

Fig. 4 Evaluate the effect of sample size on the overall prevalence of sleep disorders among postmenopausal women



**Fig. 5** Evaluate the effect of year studies on the overall prevalence of sleep disorders among postmenopausal women



**Table 2** Overall prevalence of sleep disorders among postmenopausal women by menopausal stages

Menopausal stage	Number of studies	Sample size	$I^2$	Prevalence
Premenopausal	6	2008	98.8	46.5% (95%CI: 22.6–72.1%)
Perimenopausal	6	4677	99.08	50.3% (95%CI: 27.7–72.7%)
Postmenopausal	13	12216	97.6	54.7% (95%CI: 47.2–62.1%)

**Table 3** Prevalence of various sleep disorders among postmenopausal women

Sleep disorder type	Number of studies	Sample size	$I^2$	Prevalence
Poor sleeper	4	2185	97.04	57.6% (95%CI: 44.3–69.9%)
Sleep apnea	13	8046	99.02	30.6% (95%CI: 15.5–51.4%)
RLS	3	1040	97.5	63.8% (95%CI: 10.6–96.3%)
Insomnia and DIMS	24	15721	98.04	37.6% (95%CI: 31.8–43.7%)
Sleepiness	9	1709	97.8	35.7% (95%CI: 18.2–58.1%)
Wake disorders	11	4018	94.2	9% (95%CI: 5.5–14.3%)

**Table 4** Prevalence of various sleep disorders in postmenopausal women by menopausal stage

Sleep disorder type	Menopause	Number of studies	Sample size	$I^2$	Prevalence
Sleep apnea	Premenopausal	5	3018	98.3	25.7% (95%CI: 8.9–55%)
	Postmenopausal	8	5028	99.2	35.2% (95%CI: 12.9–66.5%)
RLS	Postmenopausal	2	1013	97.7	53.1% (95%CI: 3.1–97.6%)
Insomnia and DIMS	Perimenopausal	10	5481	97.6	37.6% (95%CI: 28.5–47.7%)
	Postmenopausal	14	10240	98.3	37.4% (95%CI: 29.5–46.2%)
Sleepiness	Premenopausal	4	606	97.5	29.5% (95%CI: 8.8–64.5%)
	Postmenopausal	4	968	98.6	34.2% (95%CI: 8.5–74.5%)
Wake disorders	Premenopausal	4	1562	95.5	5.4% (95%CI: 1.5–17.2%)
	Perimenopausal	3	821	89.8	8.8% (95%CI: 4–18%)
	Postmenopausal	4	1635	94.3	14.2% (95%CI: 7.1–26.4%)

postmenopause stage as 23%, and 9% at the premenopause stage, showing the higher prevalence of this disorder during postmenopause [56].

Several accelerating and persistent factors, including hormonal changes, menopausal symptoms, and mood disorders contribute to this disorder during menopause [57, 58]. Some studies reported chronic insomnia among 31 to 42% of women at the end of the perimenopause period [59]. A study conducted in China on 305 women reported that the prevalence of this disorder in perimenopause was 21%, which is more than in postmenopausal women with a prevalence of 14.7% [39]. Valiensi et al. reported that insomnia among postmenopausal women was 15% and Yang et al. reported that parasomnia was only 10% higher among the perimenopause population than postmenopause [60]. Based on a study in Brazil, insomnia in postmenopausal was 61.1%, yet this figure was reported at 55.9% among perimenopausal [18].

A study by Smith et al. showed that the incidence of insomnia at any stage of menopause could not predict the incidence of this disorder at other stages of menopause [61]. The most common sleep disorder in postmenopausal women is RLS at 63.8% [1, 62]. A study in Egypt reported the RLS, with incidences showing 87.9% among postmenopausal and 81% in premenopause [34]. In the present meta-analysis, parasomnia was most prevalent in the postmenopausal period, then in the perimenopause period, and the least prevalent in the premenopausal period. In general, the least common sleep disorder among postmenopausal was wakefulness disorder with a prevalence of 9% [16].

## Conclusion

In view of the growing population of postmenopausal women, the importance of understanding the frequency and the effect of sleep disorders in this demographic group has taken on new urgency. Policymakers may use the results of the present meta-analysis to plan future healthcare, emphasizing the importance of sleep health education, treatment of sleep disorders, and improving the health of menopausal women as a research priority.

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**Data availability** Datasets are available upon reasonable request.

## Declarations

**Ethical approval** All steps of this study were in accordance with the ethical standards of the KUMS Ethics Committee (IR.KUMS.REC.1401.096) and the Declaration of Helsinki.

**Informed consent** This article is a review study and does not include any studies with human participants.

**Conflict of interest** The authors declare no competing interests.

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