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Interventions to improve the sleep of nurses: A systematic review

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Abstract

Nurses are at a high risk for short sleep duration and poor sleep quality due to irregular work schedules and high occupational stress. Considering the effect of nurses' sleep on the safety and health of themselves and their patients, it is important to promote healthy sleep for nurses. We sought to synthesize the published experimental and quasi-experimental studies that address interventions to improve sleep in nurses. A systematic search was conducted for studies published in English up until May 15, 2023, using the databases PubMed, CINAHL, Academic Search Ultimate, and PsycINFO. In total, 38 articles were included, covering 22 experimental and 16 quasi-experimental studies with sample sizes ranging from 9 to 207. Studies were assessed using the Cochrane Risk of Bias tool and considered as low to medium quality. Thirty-six of the 38 studies reported positive findings for at least one sleep outcome. Intervention types included aroma therapy, dietary supplements, cognitive behavioral therapy, light therapy, mind-body therapy, sleep education, exercise, napping, shift schedule modification, and multicomponent intervention, all of which showed moderate effectiveness in promoting sleep outcomes of nurses. Comparing and contrasting studies on specific interventions for improving sleep in nurses is sparse and often equivocal. With the variations of research methodology and outcome measures, it is difficult to make a conclusion about each intervention's effectiveness on specific sleep outcomes. Additional high-quality research, including randomized controlled trials, is needed to evaluate strategies for improving sleep in this unique, safety-sensitive occupational group.

KEYWORDS

nurses, sleep intervention, sleep promotion, systematic review

1 | INTRODUCTION

To provide around-the-clock patient care, many nurses are assigned to shift work. As a result, nurses are at a great risk for decreased sleep quantity and quality (Rosa et al., 2019; Sun et al., 2019). More recently, the prevalence of poor sleep among nurses increased due to high stress related to the COVID-19 pandemic (Salari et al., 2020). Night shift nurses who sleep during the day often report shortened and disturbed sleep, thereby accumulating a significant amount of sleep debt, which contributes to long-term exhaustion (Cheng & Cheng, 2017; Zhang et al., 2019).

Shift work can reduce sleep quantity and quality and may affect the overall well-being of nurses and other healthcare professionals (Books et al., 2017; Ganesan et al., 2019). Maladaptation to shift work may lead to the development of Shift Work Sleep Disorder, a circadian rhythm disorder (Pallesen et al., 2021) caused by the misalignment between internal circadian rhythms and the work/sleep schedule (Wickwire et al., 2017). Insufficient sleep adversely affects many nurses and often results in fatigue at work, decreased quality of life, and adverse physical and mental health outcomes such as musculoskeletal injuries and depression (Chaiard et al., 2019; Owens et al., 2017; Zhang et al., 2017). Fatigue, often resulting from short and poor sleep as experienced by nurses, tends to reduce the ability to concentrate and make correct judgements, leading to the possibility of errors and injuries (Scott et al., 2014) and drowsy driving and motor vehicle crashes (Imes et al., 2023; Smith et al., 2021). To avoid these negative outcomes, promoting strategies for improved sleep for nurses would likely enhance patient safety. Sleep promotion, either by individual nurse behavior or by workplace policies and activities, can benefit employees, patients, and their institutions.

Nurses are a unique occupational group, predominantly comprised of women, many of whom hold primary responsibilities for child, family, and/or elder care at home. In 2019, the Census Bureau reported that there are more than three million nurses in the United States, and over 85% of them are women (United States Census Bureau, 2019). There have been several review articles targeting sleep promotion in the general workforce, predominantly focused on men (Albakri et al., 2021; Redeker et al., 2019; Soprovich et al., 2020), yet those recommendations may not be suitable for nurses who are primarily women with different responsibilities and shift schedules. Considering the long and irregular work hours, overnight shifts, physical and psychological work demands, and limited time available for sleep, nurses face multiple obstacles in obtaining sufficient and quality sleep (Redeker et al., 2019). More efforts to promote sleep of nurses are needed to ensure a healthy workforce and high quality of patient care (Caruso & Hitchcock, 2010; Rogers, 2008).

Sleep promotion strategies aimed at the general workforce include sleep disorders screening/evaluation and treatment, and pharmacological and nonpharmacological strategies including educational, environmental, behavioral, supportive, and multicomponent treatments (Albakri et al., 2021; Redeker et al., 2019). However, there is sparse evidence regarding current evidence to promote sleep in the nursing population. Therefore, the objective of this systematic review is to synthesize published literature that addresses the effectiveness of interventions to improve sleep in nurses.

2 | METHODS

2.1 | Search strategy and data extraction

A systematic literature search in PubMed, CINAHL, Academic Search Ultimate, and PsycINFO was performed on May 15, 2023. The publication time frame was not limited to capture all relevant literature. The search keywords included three broad categories (sleep, nurse, and intervention), each with a defined broad subset of keywords, as documented in Supporting Information: Table 1.

The first author (Y. Z.) screened manuscript titles and abstracts. Full-text articles were screened independently by two authors (Y. Z. and Y.-J. L.), discrepancies were discussed, and consensus was reached. Figure 1 illustrates the PRISMA flow diagram (Page et al., 2021).

2.2 | Eligibility criteria

The inclusion criteria were: (1) types of study: experimental or quasi-experimental; (2) types of participants: nurses only; (3) types of outcomes: sleep as a primary outcome. Sleep was defined broadly, including duration, latency, deprivation, insufficiency, maintenance, quality, disturbances, disorders, problems, insomnia, and sleepiness; and (4) full text in English language. This review excluded: (1) studies that tested an intervention with healthcare/shift workers including nurses as only part of the sample; (2) studies that tested an intervention (e.g., nutrition, exercise) measuring sleep as a secondary outcome; and (3) observational studies, protocol papers, and reviews and meta-analyses. We used reviews and meta-analyses to ensure we captured all relevant studies. When a paper did not mention sleep as a primary or secondary outcome yet described sleep-related data, our study team discussed the focus of the intervention to ascertain whether the paper should be included or excluded.

2.3 | Assessment of methodological quality

Risk of bias was graded using the Cochrane Risk of Bias tool (Higgins et al., 2011) for randomized controlled trials (RCTs). This tool covers seven items to evaluate the risk of bias, including: Random sequence generation, allocation concealment (describing the method used to conceal the allocation sequence in sufficient detail), blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other bias (Higgins et al., 2011). Each item was graded as "(+) low risk of bias," "(—) high risk of bias," or "(?) unclear risk of bias," based on the definitions and samples provided in the tool. The overall assessment of risk of bias was graded as "(+) low risk of bias" when there were four or more items receiving low ratings; or as "(—) high risk of bias" when there were three or fewer items receiving low ratings.

2.4 | Data synthesis

Data synthesis began by summarizing study results in tables. Studies were grouped first by the study design, then by the intervention types. Intervention types were generated based on common sleep interventions identified from previous reviews (Albakri et al., 2021; Capezuti et al., 2018; Redeker et al., 2019). Each type was discussed within the study team for inclusion as a major category in this review.

The first author (Y. Z.) began the analysis by systematically reviewing each manuscript at least twice on the abstract, methods, results, and discussion, and completed Table 1, covering major study

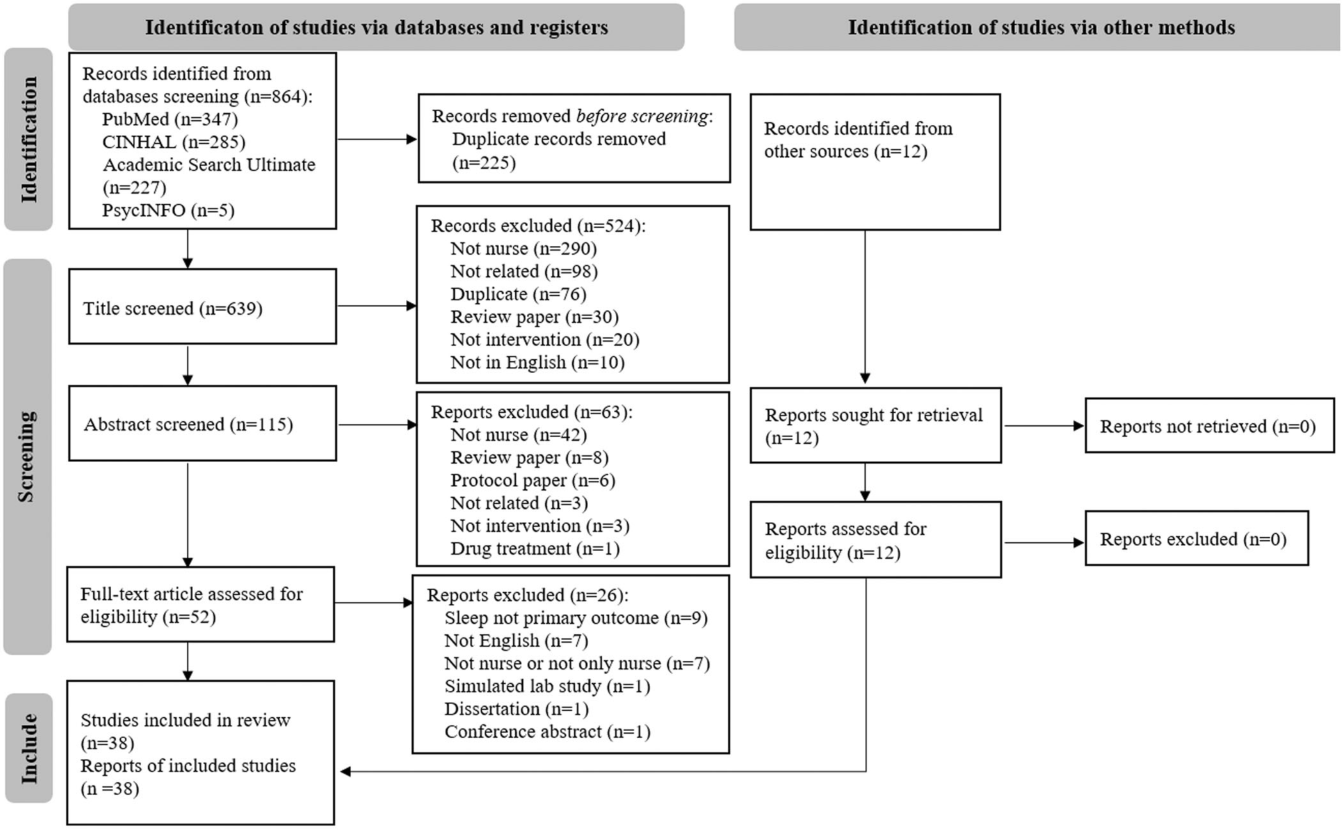

FIGURE 1 Flow diagram of the literature search. Adapted from Page et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Journal of Clinical Epidemiology*, *134*, 178-189.

characteristics. Each manuscript was then reanalyzed independently by a coauthor (H. M. L., L. K. B., Y.-J. L., or J. F. D.) on each domain in Table 1 for information accuracy. Discrepancies were checked by a third coauthor and discussed until a consensus was reached. Table 2, quality appraisal, followed the same synthesis process as Table 1.

3 | RESULTS

3.1 | General characteristics of included studies

In total, 38 articles met the inclusion criteria and were included; 22 (58%) were experimental and 16 were quasi-experimental studies. The earliest published study was in 2002. The sample sizes ranged from 9 to 207. These studies took place in various countries, including the United States, Canada, Iran, Denmark, Israel, Norway, Turkey, Spain, Netherlands, Sweden, France, Australia, China, India, Japan, Korea, Taiwan. Table 1 describes the study characteristics.

3.2 | Study sample characteristics

In total, the 38 articles involved 2395 participants, with a majority being female (on average 91%, range 56%–100%) and a mean age ranging from 26 to 54 years. Participants included nurses working night shifts, evening/night shifts, rotating shifts, and dayshifts, yet 15 studies did not specify the work shifts. Although most studies included healthy participants, seven studies included nurses with baseline sleep/fatigue/health complaints (Hausswirth et al., 2022; Huang et al., 2013; Morimoto et al., 2016; Mousavi et al., 2020; Niu et al., 2021; Yazdi et al., 2017; Zhou et al., 2022).

3.3 | Quality appraisal

Table 2 summarizes the biases and qualities of the RCTs. Overall, 7 out of 22 RCTs were graded as low risk of bias (good quality) (Baradari et al., 2018; Chang et al., 2017; Cyr et al., 2023; Hsu et al., 2021; Mousavi et al., 2020; Niu et al., 2021; Zhang et al., 2020), and the rest were graded as high risk of bias. Dropout rates of the RCTs were moderate, with 10 RCTs reporting dropout rates of <10%, and 12 RCTs reporting dropout rates from 12.5% to 77% (Aarts et al., 2020; Bjorvatn et al., 2021; Booker et al., 2022; Carter et al., 2013; Dahlgren et al., 2022; Fang & Li, 2015; Hoshi et al., 2022; Lee et al., 2014; Morimoto et al., 2016; Omeogu et al., 2020; Scott et al., 2010b; Zhang et al., 2020). All others were quasi-experimental studies and considered high risk of bias.

TABLE 1 Characteristics of experimental and quasi-experimental studies examining sleep interventions in nurses.

Source country	Population subjects (N) women (%)	Mean age (year)	Intervention duration (follow-up)	Intervention	Control	Main sleep-related outcomes	Additional outcomes	Conclusion on main sleep-related outcomes (comparison with control)
Experimental								
Aroma therapy								
Chang et al. (2017) Taiwan	Nurses on monthly rotating nights shifts 50 100%	29	4 weeks (weekly follow-up)	An aroma therapy massage with music (25 min massage + 35 min rest), once a week for 4 weeks	Lay down with music (60 min rest), once a week for 4 weeks	PSQI total and subscale scores	Take-home sleep detector, Ezsleep	There were no differences in PSQI total score, but a significant improvement in sleep quality at postintervention in the intervention group compared to the control group. There were significant improvements in PSQI total score, subjective sleep quality, sleep disturbance, and daytime dysfunction in the intervention group compared to baseline.
Hsu et al. (2021) Taiwan	ER and ICU nurses 103 92.7%	31	4 weeks (4 & 8-week follow-up)	50 min lavender essential oil massage with music, once a week for 4 weeks	None	PSQI-Chinese total score	Actigraphy, HRV, OBI-Chinese	There were no differences between the intervention and control group on PSQI total score at postintervention and 8-week follow-up. For the intervention group, the self-reported PSQI score revealed an improvement at postintervention and 8-week follow-up compared to baseline.
Nasiri and Boroomand (2021) Iran	Nurses on rotating shifts 80 88.8%	29	2 h in a typical night shift	Wear a fabric (surgical) mask with a drop of rosemary essential for 5–10 min followed by 10–15 min removal, repeatedly for 2 h	Wear a fabric mask with a drop of distilled water for 5–10 min followed by 10–15 min removal, repeatedly for 2 h	KSS, ESS	None	Compared to the control group, intervention group had significantly decreased sleepiness and increased alertness at postintervention.

(Continues)

TABLE 1 (Continued)

Source country	Population subjects (*N*) women (%)	Mean age (year)	Intervention duration (follow-up)	Intervention	Control	Main sleep-related outcomes	Additional outcomes	Conclusion on main sleep-related outcomes (comparison with control)
Dietary supplements								
Baradari et al. (2018) Iran	ICU nurses 53 92.5%	31	1 month	220 mg zinc sulfate capsules every 72 h for 1 month	Placebo every 72 h for 1 month	PSQI total score and subscale scores	Serum zinc level	There were significantly improved PSQI total scores and subjective sleep quality scores at the postintervention in the intervention group compared to the control group.
Mousavi et al. (2020) Iran	Nurses with significant fatigue 105 88%	35	4 weeks	100 mg CoQ10 capsule twice daily	Placebo twice daily	PSQI total score	Fatigue score on nurse's fatigue scale	There was significantly improved PSQI total score in the intervention group compared to the baseline and the control group.
Zhang et al. (2020) China	Nurses on a rotating three-shift schedule 38 100%	29	1 month	10 g Shimian granules twice daily for 1 month, plus sleep hygiene education	Placebo twice daily for 1 month, plus sleep hygiene education	ISI 1 day before initial treatment and 1 day after last treatment	PVT, HADS, HADS-A, and HADS-D 1 day before initial treatment and 1 day after last treatment, salivary melatonin and proinflammatory cytokine at bedtime every 7 days	There were significant decreases in insomnia severity at postintervention in the intervention group compared to the control group.
Cognitive behavioral therapy								
Dahlgren et al. (2022) Sweden	Nurses with less than 12 months' work experience 207 88%	27	4 weeks (6-month follow-up)	Three 2.5 h group-based proactive recovery program sessions based on CBT and motivational interviewing techniques	Waitlist control–usual care and then receive the intervention after follow-up	ISI, KSQ	SMBQ, WIPL, somatic symptom scale-8, PSS, DBAS-10	There were no significant differences in ISI or KSQ between the two groups at postintervention and follow-up.
Zhou et al. (2022) China	Nurses with chronic insomnia 118 98%	30	6 weeks	e-aid CBT-I	None	PSQI, ISI	GAD-7, PHQ-9	There were significant improvements in sleep quality and insomnia severity in the intervention group compared to the control group and baseline.

TABLE 1 (Continued)

Source country	Population subjects (*N*) women (%)	Mean age (year)	Intervention duration (follow-up)	Intervention	Control	Main sleep-related outcomes	Additional outcomes	Conclusion on main sleep-related outcomes (comparison with control)
Light therapy								
Tanaka (2011) Japan	Nurses working rapid day-night rotating shifts 61 100%	30	1 month	10 min morning bright light exposure using bright light device in the workplace before 7:30 a.m. for all day-shift workdays	Crossover control—usual care then receives the intervention after 1 week washout period	KSS, night sleep by 0–10 VAS	CIS, RT, and number of lapses by PVT, frequency of perceived adverse events and near misses	There were significant improvements on sleepiness and night sleep for day-shift days in intervention periods compared to control periods.
Huang et al. (2013) Taiwan	Nurses with high ISI score, working three-shift rotation 92 100%	30	At least 10 days during 2 weeks	Exposure to bright light for ≥30 min during the first half of the evening/night shift and wearing dark sunglasses after shift	No exposure to bright light, but wearing dark sunglasses after shift	ISI	HADS	The ISI score was significantly improved in the intervention group compared to the control group and the baseline.
Rahman et al. (2013) Canada	12 h day or night shift nurses 9 56%	31	8-week randomized crossover design	Wearing glasses fitted with short-wavelength filters during night shifts	Receiving standard indoor light during night shifts	PSG, sleep diary	Saliva melatonin assays, subjective and objective alertness (self-report scale and PDA), CES-D, ESS	There were significant increases in TST and SE and decreases in WASO in the intervention group compared to the control group for nighttime sleep, but no significant differences between groups for daytime sleep.
Griepentrog et al. (2018) US	Night shift ICU nurses 43 71%	29	One night shift, cross-over	10 h exposure to high illuminance white light	10 h exposure to standard ambient fluorescent lighting	SSS	Number of lapses and errors on PVT, PVT median response time, salivary melatonin concentration	There was a significant reduction of SSS score at the end of the night shift in the intervention group compared to the control group.
Bjorvatn et al. (2021) Norway	Nurses working at least three consecutive night shifts 35 80%	35	Three consecutive night shifts, counter-balanced randomized cross-over	Sit in front of a bright light box for 30 min at each night shift, the timing of light exposure was delayed by 1 h at each following night shift	Sit in front of a red dim light box for 30 min at each night shift, the timing of light exposure was delayed by 1 h at each following night shift	ATS, KSS	PVT, mood and energy, caffeine intake	Heavy eyelids significantly reduced during the night shifts in the experimental condition compared to the placebo condition. No differences in sleepiness between the two conditions during or after the night shifts.

(Continues)

TABLE 1 (Continued)

Source country	Population subjects (*N*) women (%)	Mean age (year)	Intervention duration (follow-up)	Intervention	Control	Main sleep-related outcomes	Additional outcomes	Conclusion on main sleep-related outcomes (comparison with control)
Cyr et al. (2023) Canada	Nurses during COVID working rapid rotating schedules with consecutive night shifts 57 84%	31	20 days	Evening light exposure, with suggestions on staying up 1 h later on the night before first night shift, sleep using a provided 3D eye mask, wear dark sunglasses in the morning, optionally nap in the late afternoon, and expose to 40 min bright light at home before night shifts.	Chrononutrition control, with suggestions on the timing and content of meals and snacks	KSS, sleep quality scale, sleep and wake time	Fatigue, work-related errors, mood	There were significant improvements in sleepiness and fatigue, but only minor changes in sleep duration, in the intervention group compared to the baseline. There were no differences between the intervention and control group in any sleep outcomes.
Mind body therapy								
Fang and Li (2015) China	Nurses 105 100%	35	6 months	Coached group yoga sessions, 50–60 min per session, more than two sessions per week	None	PSQI total score and subscale scores	QMWS	There were significantly improved PSQI total score, subjective sleep quality, sleep duration and sleep efficiency score, and less sleep disturbances, less use of sleep medication and less daytime dysfunction in the intervention group compared to the control group.
Nourian et al. (2021) Iran	COVID first-line nurses 41 87.7%	36	7 weeks	Online MSBR program delivered through Whats App Messenger including meditation audio, yoga video readings about the nature of mindfulness and audio or video of speeches related to mind exercises	None	PSQI total score and subscale scores	None	There were significantly improved subjective sleep quality and sleep latency scores in the intervention group compared to the control group and the baseline. There was also significantly improved sleep efficiency in the intervention group compared to the baseline.

TABLE 1 (Continued)

Source country	Population subjects (N) women (%)	Mean age (year)	Intervention duration (follow-up)	Intervention	Control	Main sleep-related outcomes	Additional outcomes	Conclusion on main sleep-related outcomes (comparison with control)
Çelik and Yarali (2023) Turkey	Nurses during COVID pandemic 90 87%	29	4 weeks	40 min laughter yoga evening sessions twice each week including deep breathing exercises, warm-up exercises, childish games, and laugher exercises	Usual care (offered the intervention after posttest)	PSQI	CD-RISC	There was significantly improved PSQI total score in the intervention group compared to the control group and the baseline.
Sleep education								
Yazdi et al. (2017) Iran	Shift work nurses with clinical insomnia 100 100%	30	1 month	2 h training and a brochure about sleep hygiene practices	A brochure about sleep hygiene practices	ISI, ESS, PSQI total score and subscale scores	None	There was significantly improved ISI, ESS, and PSQI, bedtime at night, sleep latency, frequency of unwanted napping during the day, and subjective sleep quality, sleep duration, sleep efficiency, and sleep disturbances at 1-month postintervention in the intervention group compared to the control group.
Exercise								
Niu et al. (2021) Taiwan	Shift work nurses with baseline PSQI >5 60100%	26	8 weeks (4- 8,- and 12- week data collection)	Moderate-intensity aerobic exercise program including indoor treadmill walking and jogging under a rehab instructor's supervision for 8 weeks with 60 min per session and five times per week	Usual activity without regular exercise	Actigraphy TST, SL, WASO, SE	None	The intervention group showed improved TST and SE at 4- and 8-week compared to baseline. The improvement in TST continued until 12-week. There were significantly improved SL and WASO at 4-week in the intervention group compared to the control group.
Multicomponent intervention								
Yoon & Song (2002) Korea	Rotating night-shift nurses with	Range 23–27	2 days of 4-day night shifts	Mel group: 6 mg melatonin before daytime sleep with	Placebo before daytime sleep with morning sunlight permitted	TST, SL, SE, SPT by sleep log	VAS for nocturnal alertness, DS-CPT, POMS	There were significant increases in sleep period and total sleep time by

(Continues)

TABLE 1 (Continued)

Source country	Population subjects (*N*) women (%)	Mean age (year)	Intervention duration (follow-up)	Intervention	Control	Main sleep-related outcomes	Additional outcomes	Conclusion on main sleep-related outcomes (comparison with control)
	backward rotation 12 100%			morning sunlight permitted Mel-S group: 6 mg melatonin before daytime sleep with sunglasses worn to attenuate morning sunlight				melatonin treatment (Mel and Mel-S) compared to placebo, but no differences in sleep period and total sleep time between Mel and Mel-S, and no differences in SL and SE among the three groups.
Booker et al. (2022) Australia	Nurses on regular rotating or permanent night shifts 149 96%	35	Education duration is not specified, four one-on-one coaching sessions over 8 weeks	Sleep and shift work education, plus coaching sessions with individualized strategies on home-based activities such as napping and scheduled sleep, light exposure during work, caffeine consumption, sleep hygiene practice, and melatonin (clustered randomization)	Low glycemic index diet education, plus home-based activities such as food diary and taking low glycemic index foods	SWD, SHI, ISI, FOSQ-10	Ward-based sick leave, ASTNQ, MEQ, PHQ-9, GAD-7	There were no significant differences in sleep outcomes between the intervention and control group. There were significantly improved ISI and FOSQ-10 scores in the intervention group compared to baseline, but no differences in SWD and SHI.
Hausswirth et al. (2022) France	Nursing staff during COVID pandemic 45 78%	44	4 weeks	Rebalance© Impulse, a light stimulation and mindfulness training device, 30 min per session, two to three sessions per week for a total of 10 sessions	None	Actigraphy, sleep diary, perceived sleep quality, SSQ, FIRST	BP, HR, HRV, blood cortisol, and alpha-amylase concentration	SSQ, perceived sleep quality, sleep efficiency, and fragmentation index significantly improved in the intervention group compared to the control group.
Source country	**Populationsub-jects (*N*) women (%)**	**Mean age (year)**	**Interventiondura-tion (follow-up)**	**Intervention**	**Control**	**Outcomes related to Sleep**	**Additional outcomes**	**Main conclusion(comparison with control)**
Quasi-experimental								
Aroma therapy								
Seo and Park (2017) Korea	Nurses on three-shift working 60 No report of women%	>30 (72%) ≤30 (28%)	2 weeks	Dropping aroma oil to pillows every day before going to bed	No description	Self-report sleep quality	Self-report fatigue	There were significant differences in overall sleep quality at postintervention in the intervention group compared to the control

TABLE 1 (Continued)

Source country	Populationsub-jects (*N*) women (%)	Mean age (year)	Interventiondura-tion (follow-up)	Intervention	Control	Outcomes related to Sleep	Additional outcomes	Main conclusion(comparison with control)
								group. These differences were also observed on insufficient sleep, difficulty in falling asleep, difficulty in lying awake, sleep satisfaction, and difficulty in maintaining sleep.
Dietary supplement								
Franco et al. (2012) Spain	Nursing staff having at least one night shift per week 17 100%	41	2 weeks	Ingest 330 mL alcohol-free beer (containing the hop, *Humulus lupulus* L.) daily with supper	Control week not receiving the alcohol-free beer with supper (within subjects)	Actigraphy TIB, TST, SL, SE, total activity pulses during sleep	Work stress, STAI	There were significant decreases in Actigraphy sleep latency and total activity pulses during sleep after the intervention, but no significant differences in total sleep time and sleep efficiency.
Cognitive behavioral therapy								
Carter et al. (2013) US	Hospice nurses 9 89%	54	Twice, at Weeka 2 and 4 (Weeks 3 and 5 data collection)	Two 1 h group education intervention sessions about CBT-I	No control	PSQI	CES-D	There were no significant changes at postintervention.
Lee et al. (2014) US	Night shift nurses 21 95%	46	4 weeks (8-week follow-up)	4-week active control intervention including a sleep diary and weekly readings from a booklet about shift work and sleep; and 4-week SETS-SW intervention including a sleep diary and a home-based cognitive behavioral therapy	No control	PSQI, GSDS, 7 days of wrist actigraphy	CES-D, SSI	There are significant improvements on subjective PSQI and GSDS scores after the SETS-SW intervention. Subscale scores of sleep quality, onset latency, and daytime sleepiness were significantly improved after the intervention, but no significant change in objective sleep parameters assessed by actigraphy.

(Continues)

TABLE 1 (Continued)

Source country	Populationsub-jects (N) women (%)	Mean age (year)	Interventiondura-tion (follow-up)	Intervention	Control	Outcomes related to Sleep	Additional outcomes	Main conclusion(comparison with control)
Omeogu et al. (2020) US	Day shift nurses 13 100%	52	6 weeks (both 3- and 6-week data collection)	CBT-I Coach app on cellphone	No control	ISI	None	There was significant decrease on ISI score at 3 week and the trend sustained at 6 week, with 24% attrition rate.
Light therapy								
Boivin et al. (2012) Canada	8 h night shift nurses 17 59%	42	An average of 12 night shifts over an average of 19 days	Intermittent exposure to full-spectrum bright light during the first 6 h of each night shift and wearing shaded goggles during the 2 h following the end of the night shift including the commute home plus remaining in bed for 8 h	Usual habitual light environment at work and wearing clear UV-excluding goggles for the morning commute home	TST, SO, SE by Nightcap device or portable PSG	Core body temperature, melatonin markers, saliva melatonin levels	There was significant more TST (~30 min) for daytime sleep after night shifts in the intervention group compared to the control group, but no significant differences in SO and SE.
Jensen et al. (2016) Denmark	Evening/night shift ICU nursing staff 113 No report of women%	42/43	10 days with at least two evening/ night shifts in a row and two dayshifts/ days off in a row	Designated dynamic light at work	Ordinary institutional light at work	Actigraphy SE & WASO, subjective sleep quality from sleep diary	Saliva melatonin levels, subjective well-being and health	There were no significant differences in Actigraphy SE and WASO, but better self-reported sleep quality after night shifts at postintervention between the intervention and control groups. Actigraphy showed the control group had 16% more awakenings than the intervention group.
Aarts et al. (2020) Netherlands	Rapid rotating night shift nurses 23 87%	30	Three consecutive night shifts (a total of 7-days data collection)	Wearing a light therapy glass with integrated LEDs for 4 × 15 min during three night shifts, for 30 min within 2 h after awakening, and wearing the orange-tinted blue-blocking goggles during the	Wearing a placebo glass during 3 night shifts and for 30 min within 2 h after awakening, and wearing the orange-tinted blue-blocking goggles during the morning commute home	KSS, DSS, Actigraphy BT, GUT, TIB, TST, SL, SE, FI, and subjective GSQS	Person-bound light exposure, perceived effectiveness	There was no significant difference in sleepiness, but significantly lower sleepiness on commute home after the first night shift, significantly better sleep on the second recovery day, and significantly better subjective sleep quality after the first night shift

TABLE 1 (Continued)

Source country	Populationsub-jects (*N*) women (%)	Mean age (year)	Interventiondura-tion (follow-up)	Intervention	Control	Outcomes related to Sleep	Additional outcomes	Main conclusion(comparison with control)
				morning commute home				in the intervention group compared to the control group.
Hoshi et al. (2022) Japan	Rotating and regular night shift nurses 17 100%	35	2 weeks	Dark room lightening with 110 lx on the desk at the nurse station (within subjects)	Well-lit condition with 410 lx on the desk and ceiling lights	Qguri–Shirakawa –Azumi sleep inventory; sleepiness	Fatigue, malpractice/ incidents/accidents	There was no significant difference of sleep quality, but increased drowsiness or lethargy on certain shifts in the dark conditions compared to well-lit conditions.
Mind body therapy								
Liu et al. (2021) China	COVID first-line nurses 140 93.6%	32	4 weeks	Nurses were provided the DBRT information guide, MP3 audio recording, demonstration video, and self-training record and required to complete the DBRT at 8 pm daily	No control	PSQI-Chinese total score and subscale scores	SAS-Chinese, SDS-Chinese	There were significantly improved PSQI total score, subjective sleep quality, sleep duration and sleep efficiency score, less sleep disturbances, less daytime dysfunction compared to the baseline.
Parajuli et al. (2021) India	Nursing staff 33 100%	41	4 weeks	Group yoga for 45 min/ day, 5 days/week	No control	PSQI total score	PSS	There was significantly improved PSQI score compared to the baseline.
Sleep education								
Morimoto et al. (2016) Japan	Nurses 25 88%	40	2 weeks	SHT: Two 90 min sleep education workshops on sleep hygiene education and relaxation techniques	Two 90 min sleep education workshops only	PSQI-Japanese total score and subscale scores, ESS-Japanese,	PHQ-Japanese, MBI-Japanese, SF-8 Health Survey-Japanese	There were significantly improved PSQI total score and daytime dysfunction score at postintervention in the intervention group compared to the control group. Participants with sleep problems in the intervention group showed significant improvements in sleep latency, sleep disturbance, and sleepiness scores than

(Continues)

TABLE 1 (Continued)

Source country	Populationsubjects (N) women (%)	Mean age (year)	Interventionduration (follow-up)	Intervention	Control	Outcomes related to Sleep	Additional outcomes	Main conclusion(comparison with control)
								those in the control group.
Nap								
Zion and Shochat (2019) Israel	Nurses working irregular rotating shifts including night shifts 110 100%	39	4 nights	Two nights with a scheduled 30 min nap at 4 a.m.	Two nights without a scheduled nap (within subjects)	KSS	DSST, LCT, MCTQShift	Lower sleepiness was observed at 5, 6, and 7 a.m. on nights with a nap compared to nights without a nap.
Shift schedule intervention								
Kubo et al. (2022) Japan	Nurses in a cardiac surgery unit working three-shift schedule with backward rotation 30 No report of women%	28	2 months	Shift-work schedule change to add 1 day off after every two consecutive night shifts	Non-randomized crossover control—usual care then receives the intervention afterwards	TST, SL, SE, WASO by sleep mattress sensors, total sleep hours, mean sleep duration, number of sleep opportunities by sleep log, sleep quality, and sleepiness	PVT, CRP, MQ, REQ, KPDS, UWES, fatigue, stress, quality of care, satisfaction with days off, work satisfaction	There were significant improvements in total sleep hours and number of sleep opportunities by sleep log, self-reported sleep quality, and sleepiness in the intervention group compared to the control group, but no significant differences in mean sleep duration by sleep log and objective sleep parameters from mattress sensors.
Multicomponent intervention								
Scott (2010b) US	Nurses 62 97%	38	1 h education with continuous institutional changes (4- and 12-week follow-up)	1 h fatigue countermeasure education together with institutional changes including increasing unit staffing, providing completely relieved breaks and meal	No control	PSQI, ESS, total sleep duration, workday sleep duration, nonwork day sleep duration, night shift sleep duration	Drowsiness and sleep episodes at work, drowsy driving and motor vehicle crashes, errors, and near errors	There were significant increases in total sleep duration, workday sleep duration, nonwork day sleep duration, night shift sleep duration at 4- and 12-week follow-up. There was a significant improvement in PSQI

TABLE 1 (Continued)

Source country	Populationsub-jects (N) women (%)	Mean age (year)	Interventiondura-tion (follow-up)	Intervention	Control	Outcomes related to Sleep	Additional outcomes	Main conclusion(comparison with control)
				periods, and use of strategic naps during breaks with a sleep recliner and 20 min timer				total score at 12-week follow-up, but no significant changes in ESS score.
Zhang et al. (2023) China	Frontline nurses during COVID 52 96%	31	4 weeks	Holistic sleep improvement strategies including scientific human resource management, comfortable sleep environment establishment, self-relaxation, and self-adjustment training and humanistic care	No control	PSQI-Chinese total score and subscale scores	None	There were significantly improved PSQI total score and subjective sleep quality, sleep efficiency, and sleep disturbance scores compared to the baseline.

Abbreviations: ATS, accumulated time with sleepiness scale; BP, blood pressure; BT, bedtime; CBT-I, cognitive behavioral therapy for insomnia; CD-RISC, Connor–Davidson resilience scale; CES-D, center for epidemiologic studies depression; CIS, the checklist individual strength questionnaire; CRP, salivary C-reactive protein; DBAS, dysfunctional beliefs and attitudes about sleep; DBRT, diaphragmatic breathing relaxation training; DS-CPT, degraded-stimulus continuous performance test; DSS, driver sleepiness scale; DSST, digit symbol substitution task; ER, emergency; ESS, Epworth sleepiness scale; FI, fragmentation index; FIRST, ford insomnia response to stress test; FOSQ, functional outcomes of sleep questionnaire; GAD, general anxiety disorder; GSDS, general sleep disturbance scale; GSQS, Groningen sleep quality scale; GUT, get-up time; HADS, hospital anxiety and depression scale; HADS-A, hospital anxiety and depression scale-anxiety; HADS-D, hospital anxiety and depression scale-depression; HDL, high-density lipoprotein; HR, heart rate; HRV, heart rate variability; ICU, intensive care unit; ISI, insomnia severity index; KPDS, Kessler psychological distress scale; KSS, Karolinska sleepiness scale; KSQ, Karolinska sleep questionnaire; LCT, letter cancellation task; LDL, low-density lipoprotein; MBI, Maslach burnout inventory; MEQ, morningness-eveningness questionnaire; MQ, Maastricht questionnaire; MSBR, mindfulness-based stress reduction; MTCQShift, Munich ChronoType questionnaire for shiftwork; OBI, occupational burnout inventory; PDA, personal digital assistant; PHQ, patient health questionnaire; POMS, profile of Mood states; PSG, polysomnography; PSQI, Pittsburg sleep quality index; PSS, perceived stress scale; PVT, psychomotor vigilance task; QMWS, questionnaire on medical worker's stress; REQ, recovery experience questionnaire; RT, response time; SAS, self-rating anxiety scale; SDS, self-rating depression scale; SE, sleep efficiency; SETS-SW, sleep enhancement training system for shift workers; SF, short form; SHI, sleep hygiene index; SHT, self-help therapy; SL, sleep latency; SMBQ, Shirom–Melamed burn-out questionnaire; SO, sleep onset; SPT, sleep period time; SSI, standard shiftwork index; SSS, stanford sleepiness scale; SSQ, Spiegel sleep quality questionnaire; STAI, state trait anxiety inventory; SWD, shift work disorder; TIB, time in bed; TST, total sleep time; UWES, Utrecht work engagement scale; VAS, visual analog scale; VSH, Verran Snyder Halpern scale; WASO, wake after sleep onset; WIPL, work interference with personal life index.

TABLE 2 Risk of bias in randomized controlled trials.

Source	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective outcome reporting	Other bias	Overall risk of bias
Chang et al. (2017)	+	+	—	—	+	+	?	+
Hsu et al. (2021)	+	+	+	—	+	+	?	+
Nasiri and Boroomand (2021)	—	?	—	—	+	+	?	—
Baradari et al. (2018)	+	?	+	—	+	+	?	+
Mousavi et al. (2020)	+	?	+	+	+	+	?	+
Zhang et al. (2020)	+	?	+	—	+	+	?	+
Dahlgren et al. (2022)	—	—	—	—	+	+	—	—
Zhou et al. (2022)	+	?	—	—	+	+	—	—
Tanaka (2011)	+	—	—	—	+	+	—	—
Huang et al. (2013)	+	?	—	—	+	+	—	—
Rahman et al. (2013)	—	—	—	—	+	+	—	—
Griepentrog et al. (2018)	—	—	—	—	+	+	—	—
Bjorvatn et al. (2021)	—	—	+	—	+	+	?	—
Cyr et al. (2023)	—	?	+	—	+	+	+	+
Fang and Li (2015)	+	?	—	—	+	+	—	—
Nourian et al. (2021)	—	—	—	—	+	+	—	—
Çelik and Yarali, 2023	+	?	—	—	+	+	—	—
Yazdi et al. (2017)	—	—	—	—	+	+	—	—
Niu et al. (2021)	+	+	+	—	+	+	?	+
Yoon & Song (2022)	—	?	+	—	+	+	—	—
Booker et al. (2022)	—	?	+	—	+	+	—	—
Hausswirth et al. (2022)	—	—	—	—	+	+	—	—

Abbreviations: +, low risk of bias; —, high risk of bias;?, unclear risk of bias.

3.4 | Intervention components

Intervention types included aroma therapy, dietary supplements, cognitive behavioral therapy (CBT), light therapy, mind-body therapy, sleep education, exercise, napping, shift schedule modification, and multicomponent intervention. Intervention durations varied, with some being carried out for 1 or 3 or 4 nights and others for as long as 6 months. Outcome evaluations took place immediately following the intervention, while eight studies also reported follow-ups at intervals ranging from 2 weeks to 6 months (see Table 1).

3.5 | Outcome measures

All of the studies except three (Booker et al., 2022; Cyr et al., 2023; Mousavi et al., 2020) used sleep as a primary outcome. Although these three studies did not measure sleep as a primary outcome, because the intervention in each of these studies addressed fatigue/sleep, the study team deemed them relevant and included them in this review. Main sleep-related outcomes were assessed with subjective measures such as the Pittsburgh sleep quality index (PSQI) and other scales (see Table 1); and/or objective measures generated from actigraphy, Nightcap, or polysomnography (PSG). About 40% of the studies (15/38) used the PSQI total score and/or subscale scores (see Table 1). Ten studies used an objective measure of sleep-related outcomes (Aarts et al., 2020; Boivin et al., 2012; Chang et al., 2017; Franco et al., 2012; Hausswirth et al., 2022; Hsu et al., 2021; Jensen et al., 2016; Niu et al., 2021; Rahman et al., 2013). Secondary outcomes of these interventions consisted of various objective measures and health outcomes (see Table 1).

3.6 | Effectiveness of Interventions (Table 1)

3.6.1 | Aroma therapy

Three RCTs and one quasi-experimental study reported positive changes in certain sleep outcomes from aroma therapy. These studies tested different essential oils such as lavender or rosemary or mixed oils; different administering methods such as inhaling through a mask, uniform or pillow, or massaging; and different durations of one-time administration ranging from 5–10 min to 2 h or to the entire sleep episode.

One RCT reported that compared to distilled water, nurses who inhaled rosemary essential oil reported significantly decreased sleepiness and increased alertness on the night shift (Nasiri & Boroomand, 2021). A quasi-experimental study reported improved self-reported sleep quality and reduced fatigue among nurses working three shift rotations after aromatic inhalation through pillows during sleep (Seo & Park, 2017).

Two studies (Chang et al., 2017; Hsu et al., 2021) applying aroma therapy massage reported significant improvements in PSQI scores postintervention compared to baseline, but no significant postintervention differences between the intervention and control groups. Thus, it is uncertain whether the massage or aroma therapy produced improved sleep quality.

3.6.2 | Dietary supplements

Three RCTs and one quasi-experimental study have shown positive effects on certain sleep outcomes from Zinc sulfate, CoQ10, Shimian granules, and nonalcoholic beer containing *Humulus lumpulus* L.

In a double-blind RCT of intensive care unit nurses, Zinc supplements were associated with improvements in total PSQI score and subjective sleep quality compared to placebo (Baradari et al., 2018). Similarly, Zhang et al. (2020) reported a significant decrease in insomnia severity index (ISI) scores in nurses on a rotating three-shift schedule after taking 10 g Shimian granules twice daily for 1 month compared to placebo. Moursavi et al. (2020) reported a significant increase in PSQI total score in nurses after taking 100 mg CoQ10 twice daily for 4 weeks compared to placebo. A quasi-experimental study suggested significant improvement in sleep latency (the time it takes to fall asleep after getting into bed) and total activity pulses as assessed using actigraphy after nursing staff ingesting 330 mL alcohol-free beer daily for 2 weeks (Franco et al., 2012).

3.6.3 | CBT

CBT for insomnia (CBT-I) involves guiding participants through a series of changes in sleep-related behaviors to eliminate poor sleep habits, address conditioned arousal, and reduce sleep-related worries. One of two RCT studies reported significant improvement in subjective sleep quality and insomnia severity as assessed by the PSQI and ISI among nurses with chronic insomnia after receiving a 6-week e-aid CBT-I program compared to usual care (Zhou et al., 2022). Two of three quasi-experimental studies showed improvement in nurses' subjective sleep quality and insomnia severity assessed by the PSQI and ISI when using cognitive behavioral components delivered either in-person or via mobile app (Lee et al., 2014; Omeogu et al., 2020).

However, Dahlgren et al. (2022) did not find significant differences in subjectively assessed insomnia severity or sleep quality after nurses received three 2.5 h CBT-based proactive recovery program sessions. Carter et al. (2013) did not find significant changes in subjective sleep quality assessed by the PSQI after group CBT-I education in nine hospice nurses. The small sample size ($n = 9$) in this latter study should be considered when interpreting the findings.

3.6.4 | Light therapy

Bright-light exposure is an intervention used to promote alertness during night work and improve daytime sleep by shifting the timing of the circadian system (Sun et al., 2019). Six RCTs and four quasi-experimental studies reported that light therapy has promise in improving nurses' sleep, although there was inconsistency between the studies in certain sleep outcomes. These studies included different ways of delivering the light exposure, such as enhancing the workplace light environment, having participants wear light goggles, or having them sit in front of a light box; and the light exposures were sometimes coupled with having participants wear light-blocking goggles during commute home.

Huang et al. (2013) reported improved ISI scores of nurses after exposure to bright light for ≥30 min during the first half of the evening/night shift combined with wearing dark sunglasses after shift. Similarly, Boivin et al. (2012) reported significantly more total sleep time but no differences in sleep onset latency (SOL) or sleep efficiency assessed through Nightcap device/portable PSG between the intervention and control groups. Jensen et al. (2016) reported better self-rated sleep quality but no difference in actigraphy-assessed sleep efficiency or wake after sleep onset (WASO) between the intervention and control groups. There were similar improved sleep outcomes from another two studies (Griepentrog et al., 2018; Hoshi et al., 2022).

Besides interventions with work environmental light exposure, one study reported that nurses who wore glasses fitted with short-wavelength filters during night shifts had significant increases in PSG-assessed total sleep time and sleep efficiency and decreases in WASO (Rahman et al., 2013). Similarly, another study reported nurses who wore light therapy glasses for 4 × 15 min during night shifts and then 30 min within 2 h after awakening had improvements in Karolinska sleepiness scale (KSS) scores (sleepiness) on their commute home after the first night shift (Aarts et al., 2020).

3.6.5 | Mind-body therapy

Mind-body therapy is a group of techniques that promote the interaction of mind and body function to induce relaxation. Three RCTs and two quasi-experimental studies showed mind-body therapy improved nurses' sleep. These studies tested different mind-body therapies including yoga, mindfulness-based stress reduction, diaphragmatic breathing relaxation training (DBRT); different delivery formats such as in-person or online; and different intervention durations ranging from 4 weeks to 6 months.

Two RCT and one quasi-experimental study reported that nurses had improved subjective sleep quality, as indicated by PSQI scores, following a 6-month (Fang & Li, 2015) or 4-week yoga program (Çelik & Yarali, 2023; Parajuli et al., 2021). Nourian et al. (2021) reported significantly improved subjective sleep quality and sleep latency scores after MSBR intervention compared to usual care. Liu et al. (2021) reported that DBRT significantly improved nurses' PSQI scores.

3.6.6 | Sleep education

One RCT and one quasi-experimental study showed that a sleep education program improved the sleep of nurses. These studies generally incorporated sleep hygiene education/training, with different lengths of programs ranging from 2 h to 1 day.

A sleep hygiene training showed positive effects on sleep quality, insomnia severity, and daytime sleepiness assessed by the PSQI, ISI, and Epworth sleepiness scale in nurses with clinical insomnia (Yazdi et al., 2017). Another study reported a significant improvement in the PSQI total score and daytime dysfunction between the intervention and control groups (Morimoto et al., 2016).

3.6.7 | Exercise

One RCT reported better sleep in nurses after an 8-week aerobic exercise program. Niu et al. (2021) reported improved SOL and WASO, as assessed using actigraphy, after implementing an 8-week moderate-intensity aerobic exercise program compared to those without regular exercise.

3.6.8 | Napping

One quasi-experimental study showed reduced sleepiness in nurses after a nap. Zion and Shochat (2019) found significantly lower KSS sleepiness scores during 8 h night shifts at 5, 6, and 7 a.m. on nights with a scheduled 30-min nap at 4 a.m. compared to those without a scheduled nap.

3.6.9 | Shift schedule modification

One quasi-experimental study reported improvements in sleep after a shift schedule modification. Kubo et al. (2022) found that nurses significantly improved self-reported total sleep time, sleep quality, and sleepiness when adding 1 day off after every two consecutive night shifts.

3.6.10 | Multicomponent intervention

Three RCTs and two quasi-experimental studies reported improved sleep outcomes in nurses after a multicomponent intervention, for example, melatonin intake and light exposure, education and institutional/environmental changes, or mindfulness training and light stimulation.

Hausswirth et al. (2022) found that a 4-week light stimulation and mindfulness training program significantly improved sleep quality, sleep efficiency, and fragmentation index as assessed by actigraphy in the intervention compared to control group. Booker et al. (2022) found no significant differences in sleep outcomes between intervention and control groups, but significant improvements in insomnia severity and functional outcomes of sleep quality as assessed by ISI and FOSQ-10 compared to the baseline among nurses receiving a shift work and sleep education plus coaching sessions with individualized strategies on behavior changes.

One quasi-experimental study reported that a 1 h fatigue education intervention coupled with institutional changes such as increasing staffing, providing completely relieved breaks and meal periods, and use of strategic naps during breaks significantly improved nurses' sleep quality as assessed by PSQI and sleep duration at 4- and/or 12-week follow-up (Scott et al., 2010b). Similarly, another study reported significantly improved sleep quality as assessed by PSQI in nurses after implementing holistic sleep improvement strategies including institutional and environmental changes and self-relaxation training (Zhang et al., 2023).

4 | DISCUSSION

To our knowledge, this is the first systematic review to summarize experimental and quasi-experimental studies involving interventions designed to improve nurses' sleep. Overall, this systematic review contributes important information on effective sleep promotion programs for nursing, a high-risk occupation for sleep problems.

Although 36 out of the 38 studies reported one or more positive findings regarding the sleep of nurses (e.g., sleep quality, insomnia severity), due to multiple limitations and variations in the research methodology and outcome measures, it is difficult to make a conclusion about each intervention's effectiveness on specific sleep outcomes. Two studies that found no significant effect of the interventions both used CBT. These interventions were conducted with nurses working in different shift types, durations, and rotating patterns; they varied in design and intervention type, duration, frequency and outcome measures; and the interventions were delivered in different formats. Querstret et al. (2020) conducted a scoping review of sleep-related/fatigue-management interventions for nurses and midwives and similarly reported that the literature is fragmented and lacks cohesion. In general, we found that each intervention type showed some promise in improving nurses' sleep. Among these, light therapy was most widely tested and all showed positive findings in decreasing sleepiness and/or improving sleep quality in nurses. Taking into account the design rigor and quality, dietary supplement was rated more as low risk of bias due to the ease of designing a single- or double-blind placebo-controlled trial. Among the 38 studies, light therapy, napping, and shift schedule modification are interventions designed specifically for shift workers, while other interventions have been used previously to improve sleep in the general population. Six were conducted with COVID-19 frontline nurses, demonstrating light therapy, mind-body therapy, and multicomponent interventions were effective in improving nurses' sleep during the pandemic.

4.1 | Effectiveness of interventions

Aroma therapy improved subjective sleep quality in nurses as reported in four reviewed studies. This is consistent with a meta-analysis on aroma therapy interventions for the improvement of sleep quality in the general population (Hwang & Shin, 2015). That meta-analysis revealed that the use of aroma therapy was effective in improving sleep quality and that inhalation aroma therapy was more effective than massage therapy in both healthy and unhealthy participants (Hwang & Shin, 2015). Specific guidelines for the use of aroma therapy targeted to nurses are needed. Limitations to aroma therapy include the requirement of personal effort (especially through massage), materials, and time. Research examining aroma therapy in promoting sleep has several limitations. Besides small sample sizes, the studies included here also varied by aroma oil type, administering method, and duration, limiting our ability to draw definitive conclusions about the effectiveness of aroma therapy for sleep in nurses.

Dietary supplements (e.g., Zinc, CoQ10, Shimian granules) were each found to have a positive effect on the subjective sleep quality of nurses in four reviewed studies. Supplements are nutrients or dietary intake, suggesting a link between diet and sleep. A recent narrative review of the effect of diet on sleep suggested that high carbohydrate diets and foods containing tryptophan, melatonin, and phytonutrients were linked to improvements in sleep outcomes such as insomnia in the general population (Binks et al., 2020). Although dietary supplements have shown positive effects on certain subjective sleep outcomes such as improved sleep quality and reduced insomnia severity in nurses, the mechanisms explaining the effects are not well understood. Due to an underwhelming amount of research on nurses, and these limited studies that assessed different supplements, different frequencies, and durations, we cannot be conclusive regarding the effectiveness of any specific supplement in improving nurses' sleep.

CBT-I has been demonstrated to be the most effective treatment for chronic insomnia in the general population and could hold promise to improve nurses' sleep as reported in three out of five reviewed studies. A systematic review and meta-analysis of CBT-I for chronic insomnia found improvements in SOL, WASO, total sleep time, and sleep efficiency at posttreatment, with clinically meaningful effect sizes (Trauer et al., 2015). Another systematic review suggested that CBT-I was effective for treating insomnia when compared to medications such as benzodiazepine and non-benzodiazepine hypnotic drugs, and its effects may be more durable than medications (Mitchell et al., 2012). Considering nurses' demanding work schedules, CBT may be an option to improve their sleep. However, most previous CBT-I was not targeted toward night shift workers attempting to sleep during the day, so it is unclear whether it will be effective in nurses working irregular shifts. Moreover, there are many forms of CBT-I delivery, with some requiring regular in-person or virtual meetings over many weeks, and this form of delivery may be difficult for nurses who work at night or on rotating shifts to attend. Self-paced, app-based CBT-I may better fit nurses and should be explored further.

Light therapy has previously been implemented in workplaces as a strategy to reduce nighttime sleepiness and improve daytime sleep by shifting the timing of the circadian system to better match the work-sleep schedule. There were overall positive effects reported on at least one sleep outcome for all types and durations of light exposures, including both subjective and objective sleep outcomes as reported in 10 reviewed studies. This is consistent with a meta-analysis on light therapy for sleep) problems (van Maanen et al., 2016) and another meta-analysis on light therapy for sleepiness and circadian phase shift in shift workers (Lam & Chung, 2021). Another systematic review on light therapy for shift workers included two comparable studies, one that reported a reduction of on-shift sleepiness from bright light therapy during the night, while the other did not find a significant difference in on-shift sleepiness (Slanger et al., 2016). Because certain sleep outcomes such as sleepiness and sleep efficiency showed inconclusive results in our review of studies in nurses, more rigorously designed future studies should be carried out to investigate the impact of light therapy on the sleep and sleepiness of nurses. The Working Time Society and the International Committee on Occupational Health recommend bright light use during the first three night shifts on slowly rotating (shift changes less than once a week) night shift schedules (Lowden et al., 2019). Yet, there remain questions about the best light intensity and duration for producing changes in sleepiness and/or improvements in sleep that are clinically relevant. While light therapy is promising, the feasibility of light therapy may be limited by the lack of control over workplace lighting by individual nurses and by the nature of work duties for many nurses.

Mind-body therapies have shown effectiveness in improving subjective and objective sleep of nurses as reported in five reviewed studies. This is confirmed by two recent systematic reviews of studies carried out in the general population. For example, Neuendorf et al. (2015) reported that mind-body therapies positively affect sleep quality. Wang et al. (2019) reported in a meta-analysis that mind-body therapies (e.g., meditation, Tai Chi, qigong, yoga) resulted in significant improvement in sleep quality and reduction in insomnia severity, but had no significant effect on sleep duration. Mind-body therapies also emphasize the importance of self-care, leading to a holistic approach to health and well-being (Hilcove et al., 2021). Limitations to the adoption of mind-body therapies in shift-working nurses include costs and fees for lessons and locating and accessing trained yoga practitioners. The studies in nurses used different types of mind-body therapies, different frequencies, and varied durations, limiting the ability to make a firm recommendation on any specific therapy.

Sleep education showed effectiveness in improving subjective sleep quality of nurses as reported in two reviewed studies. A recent systematic review suggested that sleep education along with support for individualized strategies to promote sleep were effective for improving the quality of sleep in general (Soprovich et al., 2020). However, it is worth noting that one sleep education study included in this review had a dropout rate of 77% (Morimoto et al., 2016), suggesting the importance of practice reinforcement after the education program. Sleep education programs provided by the workplace, whether via training sessions, brochures, or other methods, may encourage healthy sleep hygiene practice in nurses, thereby potentially improving their sleep duration and quality.

Exercise to improve the sleep of nurses was reported in one reviewed study. Although this study showed promise on nurses' sleep, more studies are needed to confirm this effect. A systematic review of RCTs suggested that chronic resistance exercise improves many aspects of sleep and has the greatest benefit for improving sleep quality in the general population (Kovacevic et al., 2018). Therefore, exercise could be a potential intervention for improving sleep in nurses. Because nurses are predominantly women working long and irregular shifts, it is important to design and test feasible exercise programs that can be easily implemented and sustained in the workforce.

Implementing naps at work in nurses as a strategy to reduce on-shift sleepiness was reported in one reviewed study. A previous systematic review on the effects of napping in night shift workers revealed that night shift napping led to decreased sleepiness and improved sleep-related performance, despite short periods of sleep inertia (grogginess and poor performance) immediately following the naps (Ruggiero & Redeker, 2014). In our review, only one study assessed the effectiveness of a nap on nurses' sleepiness. Furthermore, the study did not specifically examine the impact of the at-work nap on the nurses' sleep quantity and/or quality after work. Nap effectiveness in reducing sleepiness also depends on when and how long nurses take naps during the shift. Implementation of a nap at work requires administrative support, sufficient staffing, availability of appropriate space for napping, a culture that accepts workplace naps, and organizational policies that allow napping (Scott et al., 2010a). Feasibility and barriers to implementation need to be assessed before such a strategy can be successfully incorporated into practice.

Shift schedule modification showed positive effects in improving the sleep of nurses as reported in one reviewed study. There are many dimensions of shift schedules, including shift duration/length, shift starting and ending time, number of consecutive shifts, and number of hours and days off between shifts, leading to many ways to modify schedules. Considering the complexity of shift schedules in different organizations, it is important to tailor the shift schedule modification according to the organizational needs and feasibilities.

The combination of different interventions showed promise in improving the sleep of nurses as reported in five reviewed studies. Multicomponent interventions have been designed for the prevention and treatment of sleep problems in other populations, which all show promise in improving sleep outcomes (Epstein et al., 2012; Wilfling et al., 2021). Therefore, individualized and holistic approaches should be considered in future directions for sleep interventions in this occupational group (Alfonsi et al., 2021). Given that individual factors may affect the person's ability to cope with shift work and sleep problems, individualized interventions that use different components could be tailored to the nurse's work schedule, preferences, time availability, and other factors.

4.2 | Limitations

This review has several limitations. First, the review was limited to English language studies. The relatively small number of included studies for each intervention type, together with the variability in treatment regimen, frequency, and duration, and variability in sleep-related outcome measures, limit the conclusions that can be drawn. Second, for 15 studies it was unclear whether the nurse participants worked regular or irregular shifts. Moreover, for interventions such as aroma therapy, dietary supplements, CBT, mind-body therapy, sleep education, and exercise, it was unclear whether the interventions incorporated components to mitigate the impact of shift work on sleep. Third, given the limitations in the research methodology (e.g., small sample sizes, loss to follow-up, difficulties in blinding participants, weak designs) and the quality of many of these studies, it is difficult to compare the effectiveness of each intervention. Lastly, although sleep is an important self-care domain, it is greatly impacted by work factors. It is important to identify to what extent each of these interventions may be implemented by the workplace or affected by the workplace contexts or policies. Future research needs to address the influence of shift work and other workplace factors on the outcomes of sleep interventions for nurses.

4.3 | Conclusions and implications for practice

Of all the research on interventions to improve sleep, relatively few studies have been targeted toward nurse participants. Literature on each intervention type for improvement of sleep in nurses is limited and there are contradictory outcomes regarding the effectiveness of the intervention. Generally, light therapy, napping, and shift schedule modification are interventions designed for shift workers, among which, light therapy was most widely tested and showed promising findings in improving nurses' sleep. Most of the included studies used self-reported sleep, which may not be as reliable as objective measures. Additional research with high-quality and consistent interventions (in particular, selection of participants, frequency and duration of treatment, and appropriate objective and subjective assessments of sleep outcomes) are needed to compare between intervention types and to verify and compare their effectiveness. However, we hope that findings from this review will inform and guide future research, including the choice of interventions, and reliability and validity of outcomes measures (e.g., promoting use of objective measures). We hope that this encourages the design and implementation of evidence-based interventions to promote the sleep of nurses, which may in turn improve their work performance, productivity, and overall health.

Workplace context such as shift work is important to consider in relation to sleep promotion programs in the nursing workforce. Some of the interventions require administrative support (e.g., schedule changes), environmental changes in the workplace (e.g., light therapy), or availability of space on the unit (e.g., napping). Feasibility, facilitators, and barriers to implementation need to be assessed by both end-users and managers before workplace programs can be successfully implemented and sustained. The design and implementation of such programs should also consider nurses' long and irregular work schedules, nonwork responsibilities, as well as their individual needs and interests. For example, the convenient location, schedule, duration, and frequency of an intervention program should be planned to accommodate nurses' working schedules. Participatory process engages workers to take actions to improve their own health (Baum, 2006). Therefore, workplaces should consider implementing participatory processes to improve nurses' sleep. This in turn may have a transformative effect on the success of workplace sleep promotion programs.

AUTHOR CONTRIBUTIONS

All authors have made substantial contributions to the manuscript, meet the criteria for authorship, and have approved the final draft. **Yuan Zhang**: Conceptualization; expert search; literature analysis; original draft preparation; review & editing. **Jennifer Murphy**: Literature search and analysis; and original draft preparation. **Heidi M**. Lammers-van der Holst: Conceptualization; literature analysis; draft review & editing. **Laura K. Barger**: Conceptualization; literature analysis; draft review & editing. **Yun-Ju Lai**: Expert search; literature analysis; draft review & editing. **Jeanne F. Duffy**: Conceptualization; literature analysis; draft review & editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ETHICS STATEMENT

Because this is a systematic review of published literature, there was no involvement in the study from patients, service users, caregivers, or members of the public.

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SUPPORTING INFORMATION

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