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Feature Article

Nonpharmacological interventions to improve sleep in nursing home residents: A systematic review

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ABSTRACT

Sleep disturbance is one of the most prevalent symptoms among elderly adults, especially those living in nursing homes. Sleep disturbance adversely affects the healthcare system as well as elderly adults' quality of life. Nonpharmacological interventions have shown promising results regarding improvements in sleep. This systematic review intended to identify the effects of nonpharmacological interventions on sleep quality and nighttime sleep among nursing home residents. We searched both English and Chinese databases through December 2018 and found 28 eligible studies describing five types of interventions: physical activity (n = 6), light therapy (n = 5), mind-body practices (n = 2), complementary and alternative therapy (n = 8), and multicomponent interventions (n = 7). Although the wide variety of interventions in each category limited the generalizability of the results, physical activity, mind-body practices, acupressure and chamomile extract intake demonstrated positive and promising impacts on sleep quality and nighttime sleep. Due to the small number of included trials, the results should be interpreted cautiously. Further higher-quality studies concerning nonpharmacological treatments are needed.

Introduction

The elderly population is rapidly increasing and is expected to reach 2.2 billion by 2050, representing nearly 30% of the total population.[1] The emergence of multiple chronic diseases and aging of the population have imposed greater pressures on the healthcare system. The demand for high-quality healthcare service may engender more challenges for society, and treatment of patients with chronic diseases will increase expenses.[2,3] Sleep plays a vital role in maintaining metabolic homeostasis and guaranteeing our normal function.[4] However, the prevalence of sleep disorders increases with age, and these disorders often occur in adults over 60 years of age, with at least 40% of elders experiencing sleep disorders, which are often associated with indications of depressive symptoms, cognitive impairment, poor health and lower quality of life.[5] Compared with young people, elderly adults are prone to have more difficulty falling asleep at night and reduced total sleep time.[6,7]

A report showed that with the significant increase in the aging population and the prevalence of impaired health status, elders greater than 60 years old, especially those over 85 years of age, are more likely to be admitted to nursing home facilities.[8] Two studies conducted by Alessi and Rao revealed that elderly individuals in nursing homes suffer from more sleep problems and cognitive impairments than community residents.[9,10] Some older adults living in nursing homes are unable to become accustomed to the routines and are particularly vulnerable to sleep disorders due to a variety of underlying factors, including internal and external attention problems.[10] Aged-related factors consist of changes in sleep structure and advanced circadian rhythm disorders.[11,12] Greater sleep fragmentation and excessive daytime napping are recognized as natural processes as people age.[13] Apart from medical and psychiatric factors, lighting, noise, a high or low room temperature and an inappropriate environment also influence nighttime sleep, thus resulting in more awakening events.[14,15] In addition, a sedentary lifestyle, lack of physical activity and demented status result in sleep disorders and disturbed rest-activity rhythms in nursing home residents.[9]

The practice of prescribing hypnotic medication to elders with sleep disorders is common but not recommended.[16] Elderly people take multiple medications due to various chronic medical morbidities and neurologic symptoms. A recent meta-analysis revealed a high prevalence of polypharmacy in nursing home, with up to 65% of residents taking more than 10 different medications.[17] Adults given some specific sedative-hypnotics have an increased risk of sleep problems, depression, psychomotor defects, hip fracture and falls.[18,19]

Abbreviations: AIS-T, Athens Insomnia Scale-Taiwan; ATG, Actigraphy; ISI, Insomnia Severity Index; PSG, Polysomnography; PSQI, Pittsburgh Sleep Quality Index; SDI, Sleep Disorders Inventory.

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Given the adverse effects of many medications, careful consideration is required before prescription. Therefore, healthcare providers are increasingly turning to effective nonpharmacological therapies to treat sleep disturbance in nursing homes.[20] Nonpharmacological approaches, including physical activity, light therapy, mind-body practices, sensory interventions and multicomponent interventions, have all demonstrated promising results.[21,22] The aim of this systematic review is to summarize the evidence available in the literature related to nonpharmacological interventions to improve sleep quality and nighttime sleep among nursing home residents and to offer healthcare providers a concise direction for current research on this topic.

Method

Search strategy

The review was conducted following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. We searched for relevant studies published until December 2018 in both Chinese- and English-language databases: CENTRAL, PubMed, Embase, the Cumulative Index of Nursing and Allied Health Literature (CINAHL), Web of Science, Clinical Trials.gov, PsycINFO, Chinese National Knowledge Infrastructure (CNKI), Weipu (VIP), China Biology Medicine disc (CBM) and Wanfang Data. An evaluation of the reference lists of the included papers and relevant systematic reviews and a snowball search were conducted manually to identify articles that were not discovered by the search strategy. Finally, we limited the articles to those written in Chinese or English. A combination of MeSH and entry terms was used: (nursing home OR homes for the aged OR long-term care OR assisted living facilities OR residential facilities OR institutional care OR institutionalized) AND (sleep-wake disorder OR sleep deprivation OR disorders of excessive somnolence OR sleep initiation and maintenance disorders OR sleep hygiene OR sleep latency OR insomnia OR circadian rhythm OR sleep disorder OR sleep disturbance OR sleep problem) AND (randomized controlled trial OR controlled clinical trial OR randomized OR randomly). The same search strategies were utilized for the electronic databases.

Eligibility criteria

Types of studies
Experimental studies involving randomized control trials (RCTs) were considered for inclusion. Both individual and cluster designs were included.

Participants
Elders were included if they were over 60 years of age and were living in a nursing home, institutional facility or long-term care or assisted living facility.

Outcomes
The included studies were assessed by standardized, objective measurements (e.g., polysomnography (PSG) and actigraphy (ATG)) or subjective measurements (e.g., the Pittsburgh Sleep Quality Index (PSQI), Athens Insomnia Scale (AIS), Sleep Disorders Inventory (SDI), sleep diaries, sleep logs and staff observation scales). Sleep quality and nighttime sleep were considered primary or secondary outcome measures.

Types of interventions
Nonpharmacological interventions.

Quality assessment

We used the "risk of bias" tool recommended by the Cochrane Collaboration to assess the quality of the studies.[23] The following seven indices were assessed: random sequence generation (selection bias), allocation concealment (selection bias), blinding of the participants (performance bias), blinding of the assessors (detection bias), incomplete outcome data (attrition bias), selective reporting (reporting bias), and other sources of bias.

Study selection and data extraction

After duplicate studies were identified and removed (EndNote X8), two reviewers independently screened the titles and abstracts of all the articles. The reviewers then read the full texts of the potential studies in accordance with the inclusion criteria. If discrepancies occurred, then a third independent reviewer made the definitive decision. Finally, a standardized extraction form was used to extract the following information and data from the eligible studies: author and year, study design, participant description, intervention details, control details, sleep measurements, outcomes and findings. No meta-analysis was performed because of the variability in the types of interventions, sleep outcomes, study designs and treatment durations.

Results

The results of the selection process are listed in Fig. 1. A total of 6980 studies were identified from the English and Chinese databases. An additional 5 potential studies were retrieved from the reference lists of the relevant review articles and originally identified studies. After removing duplicate documents and careful sifting, 150 full-text articles were retrieved for further evaluation. One hundred twenty-two articles were eliminated based on their study design, settings, sleep outcomes or type of intervention. Ultimately, 28 studies met the eligibility criteria.

Study characteristics

The twenty-eight studies were all designed as RCTs, 14 of which used a cluster design, and the number of nursing home settings varied from two to nineteen. The eligible studies included 2770 participants, with the mean age ranging from 68.8 to 88.6 years. Among these included studies, the sample sizes spanned from 23 to 205. Eighty percent of the included studies recruited patients with sleep disturbances, and half of the studies included patients with cognitive impairment. These studies were largely conducted in the United States (n = 13), while the others were performed in China (n = 7), Iran (n = 2), the United Kingdom (n = 1), India (n = 1), Turkey (n = 1), Italy (n = 1), Germany (n = 1) and the Netherlands (n = 1). The important characteristics and findings of the 28 studies were tabulated with respect to study design, duration, etc. (see Table 1).

Methodological quality

Table 2 presents the quality of the RCTs assessed by using the Cochrane Collaboration tool. Most of the included studies were of high quality. The main sources of a risk of bias were allocation concealment and blinding of the participants. Details regarding randomization were clearly described in 21 of the RCTs.[15,20,24-42] Fifteen of the 28 studies reported using allocation concealment.[15,20,24,26-28,32-35,38,43-46] Some of the participants were asked to wear an actigraphy device or participate in PSG; therefore, they were not blinded to the study.[24-27,39-41,44,47] Only four of the studies displayed a high risk of bias related to blinding of the assessors.[38,40,44,46] Nine articles conducted double-blinding.[20,28,31,35–37,42,43,48] Baseline characteristics were well balanced in the included studies.

Outcome measures

Subjective and objective outcome measures were utilized. Most of the studies (n = 15) used ATG,[15,20,27-30,36,39-44,47,48] with five employing reliable scales or staff observation ratings.[39-42,44] Two studies applied both ATG and PSG.[42,47] Among the studies that used subjective instruments, 11 articles applied the PSQI,[25,26,31-33,35,37,38,46,49]

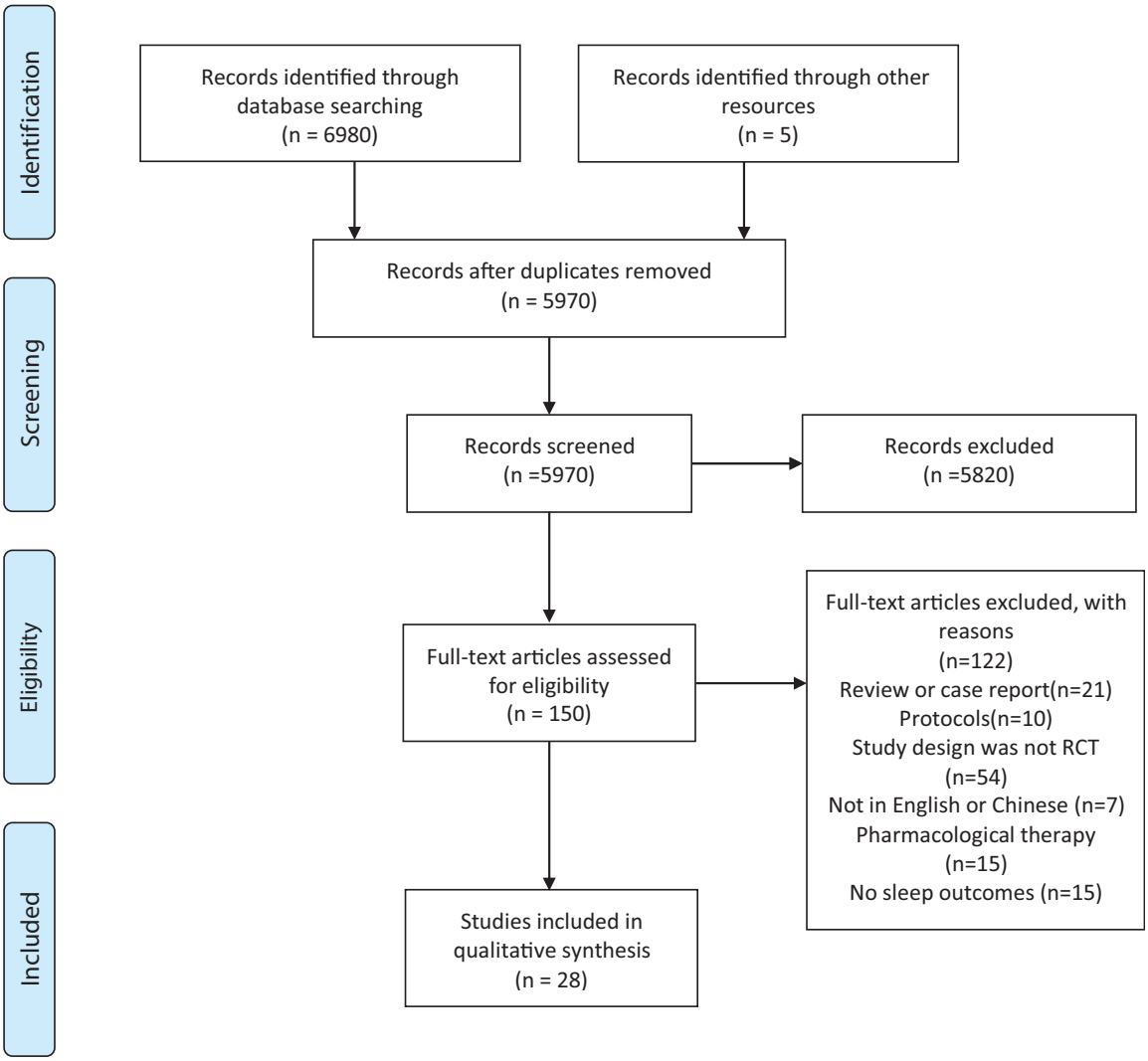

Fig. 1. Flow chart of study selection process for the review.

one used the AIS-Taiwan (T)[34] and two employed sleep logs.[35,47] Meanwhile, two articles used a mixture of objective and subjective assessment measurements.[20,47]

Study outcomes by intervention category

The included studies assessed five different types of interventions for sleep quality and nighttime sleep among people living in nursing homes. Six articles assessed physical activity,[20,24-26,47,48] five evaluated light therapy,[15,27-30] two assessed mind-body practices,[31,49] eight assessed complementary and alternative therapy,[32-38,43] and seven evaluated multicomponent interventions.[39-42,44-46] Of these 28 studies, 17 demonstrated positive findings, 4 reported mixed results and 7 found no changes. We elaborated the outcomes according to the various types of interventions.

Outcomes

Physical activity

Six studies evaluated the effects of a physical activity intervention. The forms of physical activity included aerobic exercise,[20,24,47] elastic band exercises[25,26] and walking.[48] Most of the training sessions lasted 40 min. The frequency of the interventions ranged from three to seven times per week. Two studies used both subjective and objective measurements to assess sleep.[20,47]

Among the 6 studies, two reported mixed effects and no effects of physical activity on sleep quality.[20,48] Kuck et al.[20] evaluated the effects of physical activity and social activation. After 8 weeks of training, the intervention group showed a significant improvement in subjective sleep quality compared to the control group; however, no changes were observed in objective sleep parameters, such as the number of nighttime awakenings. Eggermont et al.[48] reported no significant effects of 6 weeks of regular walking accompanied by a student on nighttime sleep and nocturnal awakenings.

Four studies reported significant effects of physical activity on sleep quality and nighttime sleep in nursing home residents compared with elders in the control group.[24-26,47]

Richards et al.[24] used PSG to record sleep in residents' rooms to collect baseline and postintervention data. The study consisted of three intervention groups: physical strength training and walking (E), individualized social activity (SA) and combined E and SA (ESA). Only the ESA group showed positive changes compared to the usual care group and significant improvements in sleep quality and nocturnal sleep. Two studies investigating the efficacy of an elastic band exercise program for nursing home residents in wheelchairs were

Table 1
Characteristics of the 23 included studies.

Type	Author, year	Study design	Participants	Final N	Intervention description	Duration	Control group	Sleep measure(s)	Sleep outcomes
Physical activity									
	Kuck (2014), Germany	RCT	Nursing home (n = 19), mean ages 83.9 years (intervention group) and 83.8 years (control group).	85	Two sessions of physical training and social activation were performed in groups of 3–8 across four days each session. Each session lasted 40–45 min.	8 wk	usual care (n = 53)	ATG, ISI	Improvement in subjective sleep quality at post-test, but no change in the objective sleep parameters.
	Eggermontv(2010), Netherlands	RCT	Nursing home (n = 19), mean age 84.8 years, women 85%	79	Residents walked for 30 min accompanied by a student every day and were allowed to have a moment to rest.	6 wk	usual care (n = 38)	ATG	No improvement in nighttime restlessness and objective sleep parameters in the intervention group.
	Richards(2011), USA	RCT	Nursing home (n = 10), mean age 81.8 years, gender not specified	165	Residents in three intervention groups participated in high-intensity physical strength training (E), individualized social activity (SA) and both (ESA) for 45 min per session.	7 wk	usual care (n = 47)	PSG	Increased nighttime sleep in the ESA group versus the control group, sleep efficiency was increased in the ESA and E groups, but no difference was found in daytime napping.
	Chen (2015), Taiwan	RCT	Nursing home (n = 10), mean age 79.1 years, range 75–84, women 49.1%	114	Residents performed wheelchair-bound senior elastic band exercises 3 times per week for 40 min each session led by two trained instructors.	6 mo	usual care (n = 55)	PSQI	Improvements in sleep quality, sleep efficiency and sleep duration at post-test, and the effects were maintained during the follow-up.
	Chen (2016), Taiwan	RCT	Nursing home (n = 10), mean age 79.1 years, range 75–84, women 49.1%	107	Nursing staff or a volunteer guided residents to participate in wheelchair-bound senior elastic band group exercises 3 times per week in two stages.	6 mo	usual care (n = 51)	PSQI	Improvement in sleep quality at 6 and 12 mo in the intervention group.
	Naylor (2000), USA	RCT	Nursing home (n = 1), mean age 75.2 years, range 65–92	23	Residents participated in structured social and physical activities in groups of 3 or more between 9 am and 10 am and between 7 pm and 8 pm.	2 wk	usual care (n = 9)	ATG, PSG, sleep log	Significant improvements in nighttime sleep in the intervention group, but no alteration in the circadian phase.
Light therapy									
	Ancoli-Israel (2002), USA	RCT	Nursing home (n = 2), mean age 85.7 years, 58 women, 19 men	46	Elderly people in the morning and evening bright light groups were exposed to 2500 lx for two hours.	18 d	evening dim red light (n = 13) daytime sleep restriction (n = 12)	ATG	No improvements in nighttime sleep or daytime alertness.
	Ancoli-Israel (2003), USA	RCT	Nursing home, mean age 82.3 years, range 61–99, 63 women	92	Patients were exposed to morning bright light or evening bright light (2500 lx) for an average of 92.1 min.	18 d	morning dim light (n = 31)	ATG	Nighttime sleep was consolidated, but no changes occurred in total sleep time and wake time.
	Dowling (2005,a), USA	RCT	Nursing home (n = 2), mean age 84 years, range 60–98, gender not specified	46	Elderly people received morning light treatment (≥ 2500 lx) for one hour.	10 wk	usual care (n = 17)	ATG	No improvements in nighttime sleep, sleep efficiency and nocturnal awakening time.

(*continued on next page*)

Table 1 (*Continued*)

Type	Author, year	Study design	Participants	Final N	Intervention description	Duration	Control group	Sleep measure(s)	Sleep outcomes
	Dowling (2005,b), USA	RCT	Long-term care facility (n = 2), mean age 70 years	70	Institutionalized patients received either morning (9.30–10.30 am) or afternoon (3.30–4.30 pm) bright light exposure (2500 lx) Monday through Friday.	10 wk	usual care (n = 17)	ATG	No significant improvement in sleep-wake or rest activity compared to the control group
	Burns (2009), UK	RCT	Nursing home (n = 2), mean age 83.5 years, 33% men	48	Elders received bright light therapy by sitting in front of a 10,000-lux light box for 2 h.	2 wk	usual care (n = 26)	ATG, behavioral observation	No significant difference in the duration of nighttime sleep between the groups at post-test.
Mind-body practices									
	Orsal (2014), Turkey	RCT	Nursing home (n = 1), mean age 75.7 years, range 60–89	64	Residents performed a progressive relaxation exercise and repeated the exercise for approximately 30 min. A nurse observed whether they correctly performed the exercise.	1 wk	usual care (n = 44)	PSQI	Significant improvement in sleep quality in the intervention group.
	Hariprasad (2013), India	RCT	Nursing home (n = 9), mean ages 75.7 years (intervention group) and 74.7 years (control group)	87	Subjects were given yoga training for 1 month and practiced yoga daily for 6 months.	6 mo	usual care (n = 58)	PSQI	Improvement in total sleep quality over time in the intervention group compared with that in the control group.
Complementary and alternative therapy									
	Chen (1999), Taiwan	RCT	Nursing home (n = 1), mean age 79.04 years, 32 women	84	Residents received acupressure on 5 acupoints for 15 min for 5 days per week.	3 wk	sham group (n = 28), usual care (n = 28)	PSQI	Significant reductions in nocturnal awakening and night wakeful time in the intervention group versus the two control groups; better sleep outcomes, such as sleep quality and duration, at post-test.
	Sun (2010), Taiwan	RCT	Nursing home (n = 2), mean ages 68.8 years (intervention group) and 67.7 years (control group)	50	Residents received standard acupressure on HT7 points for 5 min by four trained assistants.	6 wk	sham group (n = 25)	AIS-T	Significant between-group effect on sleep quality after the intervention.
	Reza (2010), Iran	RCT	Nursing home (n = 2), mean age 75.2 years	77	Residents received acupressure massage on 6 selected acupoints 3 times per week.	4 wk	sham group (n = 25), usual care (n = 26)	PSQI, sleep log	Significant improvements in sleep quality, sleep duration, and sleep efficiency in the intervention versus control groups; decreased nocturnal awakening in the intervention group.
	Lai (2017), Taiwan	RCT	Nursing home (n = 1), 42 women, 20 men	62	Residents received acupressure on some selected acupoints 3 times per week for 24 min.	8 wk	sham group (n = 31)	PSQI	Significant improvements in sleep quality at 2 and 3 months.
	Harris (2012), USA	RCT	Nursing home (n = 4), mean age 86.1 years, 32 women, 8 men	40	Residents received back massages for 3 min for two nights at bedtime.	2 d	usual care (n = 20)	ATG	Increased nighttime sleep in the intervention group, but no significant between-group effect.

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Table 1 (*Continued*)

Type	Author, year	Study design	Participants	Final N	Intervention description	Duration	Control group	Sleep measure(s)	Sleep outcomes
	Rondanelli (2011), Italy	RCT	Nursing home (n = 1), mean age 78.3 years	43	Residents took a combination of 5 mg of melatonin, 225 mg of magnesium, and 11.25 mg of zinc mixed with pear pulp.	2 mo	usual care (n = 21)	PSQI	Significant effects of dietary supplements on sleep quality and nighttime sleep.
	Gehrman (2009), USA	RCT	Nursing home (n = 1), mean age 82.9 years, range 61–95	41	Residents took a melatonin (8.5 mg immediate release and 1.5 mg time release) capsule at 10 pm before going to bed.	10 d	usual care (n = 17)	ATG	No statistically significant differences between the groups in sleep quality and nighttime sleep.
	Hajbaghery (2017), Iran	RCT	Nursing home (n = 1), mean ages 69.4 years (intervention group) and 70.7 years (control group)	60	Residents took chamomile extract (200 mg) capsules, two capsules per 24 h.	28 d	usual care (n = 30)	PSQI	Significant improvements in sleep quality and nighttime sleep compared with those in the control group.
Multicomponent interventions									
	Alessi (1999), USA	RCT	Nursing home (n = 1), mean ages 88.6 years (intervention group) and 88.3 years (control group)	29	Residents participated in a physical activity training program every 2 h per day, and a nighttime program to decrease noise, light and other sleep-disruptive nursing practices would be applied.	14 wk	usual care (n = 14)	ATG, behavioral observation	Significant increase in nighttime sleep length compared to that in the control group.
	Alessi (2005), USA	RCT	Nursing home (n = 4), mean ages 87.8 years (intervention group) and 85.9 years (control group)	108	Elders stayed out of bed in the daytime, were exposed to the sunlight for 30 min or more, and participated in a social activities program, while staff decreased nighttime light and noise and formed a regular bedtime routine.	5 d	usual care (n = 50)	ATG, behavioral observation	No significant changes in nighttime sleep time and awakening times, significant reduction in daytime sleep between the groups.
	Martin (2007), USA	RCT	Nursing home (n = 4), mean ages 87.8 years (intervention group) and 86.3 years (control group)	100	Nursing staff encouraged elders to remain out of bed in the daytime, and the elders received light exposure for more than 30 min and performed physical activities. Efforts were made to reduce nighttime light and noise.	5 d	usual care (n = 46)	ATG, behavioral observation	Significant improvement in the rest/activity rhythm compared with that in the control group.
	Ouslander (2006), USA	RCT	Nursing home (n = 4), mean ages 83.5 years (intervention group) and 82.9 years (control group)	160	The intervention included social activities in the daytime, keeping elders out of bed, sunlight exposure, decreased nighttime noise and a bedtime routine.	17 d	usual care (n = 83)	ATG, PSG	No significant differences in nighttime sleep and other objective sleep outcome measures between the two groups.
	Schnelle (1999), USA	RCT	Nursing home (n = 8), mean ages 82.6 years (intervention group) and 85.3 years (control group)	184	A photocell monitored the light level and an electric microphone monitored the sound level between 7 pm and 5 am. Nursing staff implemented an education intervention and individualized nighttime care.	8 wk	usual care (n = 94)	ATG, behavioral observation	Significant decreases in night awakening times, but no reduction in sleep duration.

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Table 1 (*Continued*)

Type	Author, year	Study design	Participants	Final N	Intervention description	Duration	Control group	Sleep measure(s)	Sleep outcomes
	Hu (2017), China	RCT	Nursing home (n = 1), mean age 72.1 years, range 60–78	410	Residents performed physical activity and received acupressure, massage, sunlight exposure, regular nighttime care and health education.	2 mo	usual care (n = 205)	PSQI	Significant difference in sleep quality between the two groups.
	Lin (2018), China	RCT	Nursing home (n = 1), mean ages 70.6 years (intervention group) and 69.1 years (control group)	64	The intervention included noise and light reductions, massage, a relaxation exercise before bed and a regular sleep routine.	12 mo	usual care (n = 32)	PSQI	Significant improvements in sleep quality and nighttime sleep compared with those in the control group.

Note: d=day(s); mo=month(s); N=number who completed the study; RCT=randomized control trial; wk=week(s).

conducted by Chen.[25,26] Poor sleep is considered to have a close relationship with inactive lifestyles, especially for elders in wheelchairs who spend limited time out of bed. The band exercise program developed by Chen consisted of a warm-up, aerobic motion and harmonic stretching—a feasible, safe and effective type of exercise.[50] In both trials, patients' sleep outcomes were assessed using the PSQI. In Chen et al.'s[26] trial, three sessions of elastic band exercises were held per week, which were led by two certified instructors who were asked to guide the exercise following a prepared video to ensure consistency across ten facilities. The authors found positive changes in sleep quality and sleep duration in the intervention group. Furthermore, significant differences were maintained between the groups throughout the remaining 6 months. Chen et al.[26] randomized 107 participants through a black box drawing and assigned them to groups in clusters of fifteen. The study showed a significant improvement in sleep quality, which confirmed the positive effect of the elastic band exercise program. In Naylor et al.'s[47] trial, a group of at least 3 people performed a structured physical activity for two weeks. Improvement in nighttime sleep was observed in the intervention group, while no significant changes were detected in the control group.

These six studies provide evidence that physical activity is safe and beneficial for sleep improvement among nursing home residents.

Light therapy

Five articles reported objective measures of sleep quality using ATG.[15,27-30] Light therapy was most often applied for elders with cognitive impairment or Alzheimer's disease living in a nursing home. The scores for cognitive status measured by the Mini-Mental State Examination (MMSE) were not consistent in these studies and ranged from moderate to severe.

Among the 5 studies, Ancoli-Israel et al.[27] reported mixed effects of bright light treatment in elders with Alzheimer's disease. The study compared the effects of morning and evening bright light exposure with those of morning dim red light exposure, which served as the control condition. The intervention consolidated nighttime sleep, while no significant changes occurred in total sleep time and the number of nighttime awakenings.

The other four studies reported no significant effects of bright light therapy on nighttime sleep in nursing home residents compared with the control group.

Ancoli-Israel et al.[15] conducted a trial with two intervention groups, including evening and morning light groups, and two control groups, including evening dim red light and daytime sleep restriction (DSR) groups. No significant changes in nighttime sleep were observed in either treatment group. Dowling et al.[29] randomized 46 Alzheimer's disease elders and tested the effect of a morning bright light intervention. The intervention group was exposed to bright light (>2500 lx in the gaze direction) for 1 h, and the authors did not report any positive results related to sleep time and the number of awakenings according to the ATG measurements. In contrast, significant changes were found in elders with an aberrant activity rhythm. Another study conducted by Dowling et al.[30] again found no effect of either morning or afternoon light therapy on nighttime sleep, sleep efficiency and daytime wakefulness after patients were exposed to more than 2500 lx emitted from a light box. Burns et al.[28] administered 2 h of light (10,000 lx at the cornea) between 10 am and noon each day for 2 weeks to dementia patients accompanied by a research nurse. Nearly all elders could tolerate light exposure for two hours. The authors reported no significant difference in the duration of nighttime sleep between the intervention and comparison groups.

These five studies provide ineffective and limited evidence that light therapy improves sleep among nursing home residents.

Table 2
Quality of assessment of the RCTs (n = 23).

Studies	Sequence generation	Allocation concealment	Participant blinding	Assessor blinding	Incomplete outcome data	Selective reporting	Other bias
Kuck[20]	L	L	L	L	L	L	H
Eggermont[48]	U	U	L	L	L	L	L
Richards[24]	L	L	H	L	L	L	L
Chen[25]	L	U	H	L	L	L	L
Chen[26]	L	L	H	L	L	L	L
Naylor[47]	U	U	H	U	L	L	L
Israel[27]	L	L	U	L	L	L	L
Israel[15]	L	L	H	L	L	L	L
Burns[28]	L	L	L	L	L	L	L
Dowling[29]	L	U	U	L	L	L	L
Dowling[30]	L	U	U	L	L	L	L
Hariprasad[31]	L	U	L	L	L	L	L
Orsal[49]	U	U	U	L	L	L	L
Chen[32]	L	L	L	U	L	H	L
Lai[33]	L	L	U	L	L	L	L
Sun[34]	L	L	L	U	L	L	L
Reza[35]	L	L	L	L	L	L	L
Harris[43]	U	L	L	L	L	L	L
Alessi[39]	L	U	H	H	L	L	L
Alessi[40]	L	U	H	L	L	L	H
Martin[41]	L	U	H	L	L	L	L
Ouslander[42]	L	U	L	L	L	L	L
Schnelle[44]	U	L	H	H	L	L	L
Hu[46]	U	L	L	H	L	L	L
Lin[45]	U	L	U	L	L	L	L
Gehrman[36]	L	U	L	L	L	L	L
Rondanelli[37]	L	U	L	L	L	L	L
Hajbaghery[38]	L	L	L	H	L	L	L

Mind-body practices

Two studies evaluated the effects of mind-body practices on sleep quality in nursing home residents using the PSQI and reported significant changes.[31,49]

Orsal et al.[49] offered a one-week progressive relaxation exercise program developed by Jacobson[51] that the participants were asked to perform before bedtime. A combination of supervised and nursing home-based muscle relaxation exercises led to significant improvements in subjectively assessed sleep according to the PSQI. In Hariprasad et al.'s trial,[31] patients performed yoga exercise for one hour per session for one month and practiced and reinforced the exercise during the next two months. Certified yoga instructors guided the elders to perform the intervention, and the control group remained on the waitlist. The authors found a significant between-group effect, indicating that yoga had beneficial effects on sleep in nursing home residents.

Complementary and alternative therapy

Eight studies evaluated the effects of complementary and alternative therapy on sleep in nursing home residents.[32-38,43] The forms of complementary and alternative therapy included acupressure, massage, chamomile extract and melatonin.

Among the 8 studies, two involved back massages and melatonin and reported no significant effects on sleep quality.[36,43] The RCT conducted by Harris et al.[43] involved administration of a 3-minute slow-stroke back massage at nighttime to older adults in a nursing home. A certified advanced nurse performed the intervention, and the control group received usual bedtime care. Although nighttime sleep increased by 36 min as measured by ATG in the intervention group, the authors did not find significant differences between the groups. Gehrman et al.[36] conducted an RCT to evaluate the efficiency of nightly melatonin in improving sleep among nursing home residents. Subjects received either placebo or melatonin (8.5 mg immediate release and 1.5 mg time release) capsules at 10 pm administered by a nurse every night. The study did not report statistically significant differences between the two groups in sleep quality and night time sleep.

The other six studies reported significant effects of complementary and alternative therapy on nighttime sleep in nursing home residents compared with the control group.[32-35,37,38] Among the four studies regarding acupressure,[32-35] the length of each session ranged from five to twenty-four minutes, except for Reza's[35] trial, which did not declare an exact duration. Two of the articles had 1 intervention group and 2 control groups: a sham acupressure group and a usual care group.[32,35]

Chen et al.[32] conducted a 3-arm study with elderly individuals in which the control group only engaged in conversation. The final results were very promising as standard acupressure significantly improved subjective sleep quality and sleep duration in the intervention group. The results from the daily sleep status record forms revealed that hours of total sleep time and nocturnal awakening time also showed significant differences among the three groups. A 6-week intervention conducted by Sun et al.[34] evaluated the effectiveness of acupressure on the Shenmen point (HT7) for patients with insomnia. Many previous studies have demonstrated the benefits of acupressure on HT7 with respect to sleep disturbance.[52,53] In the trial, four trained staff assistants administered the acupressure intervention. The mean finger-tip pressure was required to be consistent and was supervised by a registered nurse according to a standard scale. At post-treatment, a significant between-group effect favoring the intervention was found.

Reza et al.[35] evaluated acupressure effects with a sham group and a usual care group. The authors reported that the experimental group had significantly greater improvements in subjective sleep quality and decreased nocturnal awakening compared to the control groups. A post hoc comparison revealed a greater difference between the intervention and control groups during the follow-up. Lai et al.[33] implemented a training protocol with a similar procedure and similar intensity and supervision for at least 3 months and reported a significant improvement in sleep quality.

An 8-week study conducted by Rondanelli et al.[37] examined the effects of a combination 5 mg of melatonin, 225 mg of magnesium, and 11.25 mg of zinc mixed with pear pulp on sleep among nursing home residents with insomnia. Participants' nutritional status was assessed before the intervention, and the dose of melatonin was determined based on malabsorption syndrome in the elders. The subjects in the intervention group received the supplement before sleep, while the control group only received 100 g of pear pulp. The author found significant effects of dietary supplements on sleep quality and nighttime sleep. In Hajbaghery et al.'s[38] trial, residents were given either chamomile extract capsules or placebo capsules in the same manner. They were instructed to take a dose of 200 mg every 24 h for 28 days without using any other chamomile derivatives and were trained to be aware of the adverse effects of the capsules. Positive and significant improvements in sleep quality and nighttime sleep were observed compared with the control group.

These eight studies provide evidence that the effects of complementary and alternative therapy on sleep among nursing home residents are controversial.

Multicomponent interventions

Seven studies evaluated the effects of multicomponent interventions on sleep quality in nursing home residents.[39-42,44-46] Five of the articles used ATG as an objective measure of sleep, except for the two Chinese studies, which used the PSQI.[45,46] The severity of dementia in all the studies was moderate, with MMSE scores ranging from 10.6 to 13.6. Multicomponent interventions included sleep hygiene, physical exercise, acupressure, massage, and behavioral and environmental interventions.

Among the 7 studies, two reported mixed effects on sleep quality in nursing home residents.[40,42]

Alessi et al.[40] conducted an RCT lasting five days and consisting of the following interventions: asking the subjects to stay out of bed, providing the subjects with more sunlight exposure, and asking the subjects to participate in daily activity programs. No significant between-group effects were observed for nighttime total sleep or nocturnal awakenings, although a decrease in daytime napping was observed in the intervention group according to behavioral observations. In Ouslander et al.'s[42] trial, well-trained researchers provided multiple interventions to the elderly, including daytime physical activity, a regular sleep routine, and nighttime efforts to minimize noise and light. The results showed no significant changes in nighttime sleep or any of the objective outcomes based on ATG and PSG.

The other five studies reported significant effects of multicomponent interventions on nighttime sleep in nursing home residents compared with the control group.

Schnelle et al.[44] measured the effect of an intervention involving noise, light and sleep on incontinent nursing home residents that included in-service education, feedback on light and noise, measures to reduce noise, and regular incontinence night care. The authors evaluated the relationship between environmental changes and sleep quality and found no significant improvement in sleep duration; however, the authors observed a reduction in nocturnal awakening times associated with noise and light, which were both reduced significantly at night. In Martin et al.'s[41] trial, residents received similar interventions in groups of 5 to 6 subjects. The author reported large and significant between-group and study phase effects for rest/activity rhythm. Alessi et al.[39] employed a combined physical activity and environmental intervention with 29 incontinent elders in one community nursing home. The authors reported a distinct and significant improvement in total sleep time compared with the control group.

Hu et al.[46] evaluated the efficiency of an intervention including physical activity, acupressure, massage, sunlight exposure, regular nighttime care and health education and discussed their experiences. The researchers tracked and assessed the experimental conditions, adjusted the nursing interventions individually, and improved the quality of care provided to nursing home residents. The results showed significant differences in sleep quality between the two groups. Lin et al.[45] measured the effects of multicomponent interventions consisting of reductions of noise and light, massage, a relaxation exercise before bed and a regular sleep routine. The authors reported significant improvements in sleep quality and nighttime sleep compared with the control group.

These seven studies provide evidence that the effects of multicomponent interventions on sleep in nursing home residents are mixed.

Discussion

This systematic review summarized the available empirical evidence on the effect of nonpharmacological interventions on sleep quality and nighttime sleep among nursing home residents. Four of the six studies examining physical activity interventions reported a significant effect of physical activity on sleep quality and nighttime sleep in nursing home residents compared with the control group. None of the five studies regarding light therapy reported a significant effect of such interventions. Both of the studies investigating mind-body practices reported a significant effect of such interventions. Six of the eight studies examining complementary and alternative therapy reported a significant effect of these treatments. Five of the seven studies on multicomponent interventions reported a significant effect on the quality of sleep.

In this review, we found positive effects of physical activity on sleep quality and nighttime sleep in nursing home residents. Consistent with these findings, an RCT conducted by Richards *et al.*[54] considered an individualized physical activity intervention using ATG. Three weeks of physical activity resulted in significantly fewer minutes awake at night time for the participants who reported inadequate baseline nighttime sleep. Yang et al.[55] undertook a systematic review of the effect of exercise training on improving sleep quality in elderly people and found moderate positive effects on the subjects. These findings suggest that providing residents with physical activities may reduce daytime sleep and improve nighttime sleep. Walking, which is regarded as a type of aerobic activity, also benefited subjects in many ways, but we failed to find a significant effect on sleep disturbance in elders with impaired cognition,[48] possibly due to the high incidence of cardiovascular disease among elders, which aggravates sleep disturbances, and improper durations of the interventions. Although high adherence in some of the studies may have contributed to the positive results, considerable differences were noted in the methods, types of activity (such as walking, elastic band exercises, and physical resistance strength training), program durations (varying from 2 weeks to 6 months) and sleep assessment tools (such as the PSQI, PSG and ATG) among the studies; therefore, more high-quality research on physical activity is required.

Light therapy was administered to reduce sleep disorders[27] and stabilize circadian rhythms.[56,57] In our review, we did not demonstrate any compelling evidence regarding light therapy due to the paucity of articles on this topic. Our result is consistent with those of two studies that did not find an effect of light on improving sleep.[58,59] However, in an RCT conducted by Akyar et al.,[60] healthy elders were exposed to light therapy at an intensity of 10,000 lx, and their scores for global sleep quality, sleep latency and daytime dysfunction all changed positively. Moe et al.[61] also reported a negative correlation between cognitive performance and sleep quality. The patients in the included studies had severe cognitive impairments, which may influence rest-activity rhythms. However, Brewster et al.[62] found that the association between sleep parameters and cognition in community-dwelling adults is uncertain because of many covariates, such as

depression and sleep apnea. Therefore, future clinical research should be conducted to study the relationship between cognition and sleep among older adults living in the community or in nursing homes. The effects of light therapy on elders with different cognitive levels should also be investigated. The study conducted by Dowling et al.[29] applied bright light to subjects only from Monday to Friday because of a lack of nursing staff. In addition, asking patients to sit in front of light boxes for an extended period was difficult as they could have fallen asleep, especially severely demented people. Additionally, we could not guarantee the actual time of light exposure. Therefore, specific protocols for such interventions must be designed properly, including the duration, dose, frequency and supervision.

To examine the effectiveness of mind-body practices, two studies involving progressive relaxation exercise and yoga were included. Studies show that progressive relaxation exercises calm our muscles and nerves, thus reducing sleep disorders.[63] Yoga is a holistic type of exercise related to mind, body and spirit and has been confirmed to improve various symptoms of somatic and psychological dysfunction. Chen et al.[64] offered a yoga program to 55 elders in groups of twelve to thirteen for seventy minutes per session using a prerecorded tape to ensure consistency. After six months of the intervention, improvement in overall sleep quality was observed in the intervention group, and significant differences were observed between the groups for all of the sleep variables.

Several studies investigated the effectiveness of complementary and alternative therapy and revealed that acupressure and chamomile extract yielded positive results. Acupressure is a form of traditional Chinese medicine used to treat sleep dysfunctions. It is noninvasive and appears to be a potentially simple and safe technique.[65] A meta-analysis was undertaken to confirm the overall effect of acupressure on sleep disturbances, and the author concluded that it benefited people substantially.[66] Four of the included studies had a sham acupressure group, indicating that the subjects received a massage without acupoint manipulation and acupressure at the same frequencies as those in the intervention group. The acupoints were selected according to a qualified traditional Chinese physician with extensive experience, and all of the project assistants were trained until they were qualified to apply the technique. However, the acupoints were not consistent in the studies, and we could not compare the effects of different acupoints on sleep quality. Chamomile extract is recognized as a type of dietary supplement and has been proven to be useful for promoting sleep and alleviating fatigue. As an alternative therapy, the safety of chamomile extract and the low rate of side effects have been reported in many studies.[67,68] The effect of melatonin was controversial because of the different doses used and the limited number of studies.

The nursing home environment, behavioral factors and physical exercise are associated with sleep quality in residents. Many studies have demonstrated that regular sleep hygiene and reduction of sleep disruptors, such as improper nighttime care, noise and light, can significantly improve sleep quality.[19,69,70] In our review, seven trials used multicomponent interventions, and the findings revealed mixed and conflicting evidence for applying multiple interventions to elders living in nursing homes. An explanation for these results in this review is the short durations of the interventions, with two studies lasting for five days and one lasting for seventeen days. The nursing home provided regular nighttime care, made rounds, and recorded feedback regarding noise and light; however, the intervention strategies were not sufficient to reduce noise and light to proper levels and eliminate the factors influencing nighttime sleep. Multicomponent interventions resulted in a significant decrease in daytime napping and increased light exposure and physical and social activity, which may benefit sleep to a certain extent. More studies with proper intervention protocols are needed to obtain promising results.

Although the 28 included studies used valid and reliable assessment tools, the tools were not consistent across the studies. Therefore, the inconsistency of the instruments may complicate comparisons of subjective and objective sleep outcomes. Some studies used only standard subjective scales to evaluate sleep quality and depended on information provided by patients or caregivers; thus, discrepancies and inaccuracies could not be eliminated. PSG cannot be applied to elders with cognitive impairment and psychosis,[71] while ATG is considered to have high sensitivity and accuracy and is nearly as reliable as PSG (>90%).[72] In addition, the PSQI, ISI and AIS are all valid instruments for evaluating and discriminating sleep disorders. Kushida et al.[72] suggested that to increase the reliability of results, subjective tools should be employed as an adjunct. One study showed that a discrepancy exists between subjective and objective sleep measurements.[73] Therefore, if no financial constraints exist, then objective and subjective assessment measures should both be utilized.

Moreover, due to the study designs, populations, and improper instruments in some articles, we were unable to include some trials involving cognitive behavioral therapy (CBT), indoor gardening, auricular therapy and aromatherapy. Interestingly, in a meta-analysis concerning CBT for the treatment of insomnia, the author found a significant effect on sleep outcomes, including sleep onset latency and nighttime awakenings.[74] The use of nonpharmacological therapies also prevents side effects from polypharmacy and improves sleep continuity. We did not search for articles concerning pharmacological therapy and failed to compare the effects of pharmacological and nonpharmacological therapies.

In addition, the incidence of adverse events in the studies included in the review was very low. Only one trial conducted by Richards et al.[24] reported 23 cases of adverse events, such as leg pain and chest pain, which were not life-threatening and were strongly correlated with preexisting conditions. No adverse effects (e.g., deaths and falls) were observed during the interventions in the remaining studies.

Limitations

Several potential limitations should be noted. First, although we developed and conducted independent search strategies according to an experienced researcher, we may not have included all relevant studies because of the language limitation. Only studies published in English and Chinese were searched from inception to December 2018, and we did not explore unpublished gray literature, which may have influenced the final findings. Second, a total of 28 relevant trials reported sleep interventions and met the inclusion criteria. Although scholars are increasingly focusing on sleep disturbance among elders and attempts to improve sleep in adults living in institutions are becoming more common, only a small number of studies exist, and limited evidence is available to guide healthcare providers. Third, meta-analysis was not feasible and was not performed due to the substantial heterogeneity of the studies' methodologies. Fourth, because of the high heterogeneity of the included studies, we could not draw exact conclusion, but we synthesized the findings of the trials to generate recommendations regarding effective interventions. Finally, the limited durations and dosages of various interventions in some trials prevented them from achieving possible effects.

Conclusion

Sleep disturbance is an epidemic problem among geriatric subjects living in nursing homes and is recognized as having a multifactorial etiology in most elderly patients. For healthcare providers and nursing staff in nursing home facilities, the practical significance of this systematic review is valuable and meaningful. Despite the above

constraints and limitations, these findings still show that nonpharmacological interventions, especially physical activity, mind-body practices, acupressure and chamomile extract, applied to older adults living in nursing homes have positive effects on improving sleep. However, determining the most effective type of intervention was not feasible. A single treatment may not be sufficient to maximize the impact on sleep parameters; therefore, future studies should investigate whether combining several interventions can produce a more robust effect. Currently, rigorous studies exploring the effects of such interventions are lacking. Additional higher-quality RCTs are required to evaluate the potential effects of nonpharmacological treatments on improving sleep in the elderly nursing home population. The findings of this review emphasize the importance of implementing sleep assessments using both subjective and objective tools and providing suitable nonpharmacological interventions in nursing homes. Although we could not distinguish the most useful type of intervention, we still suggest that physical activity, mind-body practices, acupressure and chamomile extract may be suitable approaches for nursing home residents. Furthermore, the optimal duration, dosage, and design of interventions should be investigated in the future.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.gerinurse.2019.01.001.

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