Sleep Interventions for Informal Caregivers of Persons with Dementia: A Systematic Review

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Abstract

We conducted a systematic review on the state of the science related to sleep interventions for informal caregivers of persons with Alzheimer's disease or related dementia (ADRD). This review included English-written, peer-reviewed articles that studied the effect of an intervention on sleep health outcomes for informal caregivers of persons with ADRD. Our search yielded 15 articles that met our a priori inclusion criteria. We categorized interventions into four categories: environmental, physical, cognitive, and collaborative. Intervention effects were heterogeneous, with most yielding nonsignificant sleep health effects. There is a need for theoretically sound and robust sleep health interventions for informal caregiver samples. Future research in this area could benefit from the use of more controlled, pragmatic, and adaptive research designs, and the use of objective measures that conceptually represent the multiple domains of sleep health to enhance intervention quality.

Keywords

Sleep; Caregiving; Dementia; Alzheimer's disease

By 2050, more than 130 million individuals throughout the world will be afflicted with Alzheimer's disease or related dementia (ADRD), exceeding more than US $1 trillion in associated costs (Gao et al., 2019; Prince et al., 2016; Wimo et al., 2017). ADRD is a progressive disease associated with decline in functional status, and informal caregivers are instrumental in providing care for those with ADRD, regardless of the disease's stage or progression (Koca et al., 2017). In the United States alone, 16 million adults spend more than 20h per week serving as caregivers for persons with ADRD (Prudencio & Young, 2020). ADRD behavioral and psychological symptoms may compromise the sleep health of informal caregivers, which further impairs their ability to care for themselves and the person with ADRD (Baharudin et al., 2019; Mukherjee et al., 2017; Vaingankar et al., 2016; Worley, 2018).

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Informal caregivers of persons with ADRD commonly report poor sleep health. However, there is a limited evidence base describing sleep-focused interventions for informal caregivers of those with ADRD. The majority of existing supportive interventions targeted psychological outcomes, such as psychological well-being, knowledge, and coping (Gilhooly et al., 2016). Few intervention studies evaluated any kind of subjective or objective physical health outcomes, with most reporting subjective levels of physical health (Cheng et al., 2019, 2020). A recent systematic review identified three sleep-focused behavioral interventions that improved the sleep of informal caregivers of those with ADRD (Gao et al., 2019). However, this work focused exclusively on sleep-related outcomes, specifically sleep quality and sleep duration, which fails to capture the complexity of sleep health, which can be measured by concepts other than quality and duration (e.g., hygiene and satisfaction) (Buysse, 2014; Knutson et al., 2017).

Given the detrimental health consequences associated with serving as an informal caregiver, the development of supportive interventions for informal caregivers of those with ADRD is a national research priority (Corriveau et al., 2017). There is ample evidence linking sleep health to physical and psychological health, yet little is known about the effects of sleep interventions for these caregivers. Such information may inform future development of supportive sleep interventions for these caregivers and other informal caregiving populations, as well as improve the health of care recipients (Gallagher-Thompson et al., 2020).

Therefore, the purpose of this study was to conduct a systematic literature review of sleep interventions for informal caregivers of persons with ADRD. Specifically, we sought to describe the types of sleep interventions and sleep-health outcomes of interest for targeted sleep interventions among these caregivers. Our research was guided by the following aims:

1. Describe the current state of the science as it relates to sleep interventions for informal caregivers of persons with ADRD.

2. Examine the effects of sleep interventions on the health of these caregivers.

3. Provide evidence-informed recommendations for future clinical research that address the limitations of the state of the science focused on sleep interventions for these caregivers.

Methods

Our study's methods were guided by the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA; Liberati et al., 2009). For this study, we specified inclusion criteria and analysis methods in advance; however, the protocol was not registered.

Eligibility Criteria, Information Sources, and Search

We included all English-written, peer-reviewed articles that examined the effect of a sleep intervention on any sleep-related outcome (Ibáñez et al., 2018), among informal caregivers of persons with ADRD, regardless of study design. We defined "informal caregiver" as an individual providing unpaid care to a person with whom they have a personal relationship

(National Research Council, 2010). To improve breadth and comprehensiveness, we defined sleep interventions to include studies that examined the effect of any intervention type on a sleep-related outcome, even if it did not directly target sleep health (e.g., sleep quality, disturbance, daytime sleepiness, etc.; Knutson et al., 2017). Abstracts, conference proceedings, graduate theses/dissertations, and editorials were not included. We excluded review articles; however, we hand-searched review reference lists to identify additional relevant articles. We identified studies by searching electronic databases on March 14, 2020. We applied the same search strategy to PubMed, CINAHL, and Academic Search Complete. Specifically, our search terms contained the databases' subject heading equivalent of "Dementia," "Caregivers," and "Sleep," each connected with the "AND" Boolean operator. To enhance the relevance of our findings, we only included articles published from January 1, 2009 through December 31, 2019. Our study's lead investigator exported the search results to EndNote and used one of the program's functions to remove duplicate articles.

Study Selection, Data Extraction, and Bias Assessment

We used an unblinded systematic search strategy performed by two independent reviewers to screen studies for inclusion. We created a screening tool to maintain organization of the screening process (Polanin et al., 2019). Initially, our two study reviewers screened the title and abstract, and would search the full-text article to clarify the inclusion criteria, if necessary. Specifically, each reviewer verified the criteria of a single article in the following order: (a) written in English, (b) peer-reviewed, (c) included informal caregivers of a person with ADRD, (d) examined an informal caregiver sleep-related outcome (Ibáñez et al., 2018), (e) described the effect of an intervention on the sleep-related outcome, and (f) was not a review article. Upon completion of screening, the lead investigator examined the articles selected by the reviewers to verify congruence with the inclusion criteria and resolve screening discrepancies between the two reviewers.

We created a data extraction tool that was pilot-tested on the included articles by a single reviewer, and refined accordingly (Liberati et al., 2009; Randolph, 2009). Next, the two reviewers extracted data from the included studies and the lead investigator checked the extracted data for accuracy and completeness. They extracted the following methodological data: (a) study design (i.e., sampling method, group allocation methods, and comparison groups), (b) data collection time-points (i.e., frequency of data collection and distance between time points), (c) study setting, (d) sample descriptors (i.e., inclusion/exclusion criteria, age of caregivers and patients, gender distribution, and relationship), and (e) intervention characteristics (i.e., components, delivery method, dosing, and intervention fidelity). The extracted outcome data were the studies designated sleep outcomes (measurement and relationship to intervention exposure).

To evaluate the rigor of the included studies, our lead investigator examined each study for sources of bias using the revised Cochrane risk-of-bias tool for randomized trials (ROB 2; Sterne et al., 2019). The ROB 2 elicits evaluation of bias domains related to the study's randomization process, intervention deviations, missing outcome data, outcome measurement, and reporting practices. Within each domain, a series of signaling questions

are used to direct an algorithm that yields three possible bias outcomes from each domain (i.e., low risk, high risk, and some concern) and an overall bias evaluation. To clarify for this review, signaling questions involving specific outcomes were evaluated in terms of the specific sleep outcomes examined by each study.

Results

Our initial search yielded 643 articles to screen for inclusion; 43% were duplicates. Once our lead investigator removed the duplicates, the reviewers screened 365 full-text articles for eligibility. During the screening process, the reviewers excluded 350 articles for not meeting the inclusion criteria. The primary reasons for exclusion were not involving informal dementia caregivers (52%), not examining a sleep outcome (16%), and not describing the effect of an intervention on the sleep-related outcome (16%). Our hand search of the literature did not provide any additional articles that met our criteria. Overall, our search yielded 15 articles that met our criteria. The two screeners demonstrated acceptable interrater reliability (96.6% agreement; Cohen's $\kappa = .94$). Figure 1 illustrates the processes for the search, extraction, and identification of articles that met the inclusion criteria.

Bias Assessment

We used the ROB 2 tool to evaluate 14 of the 15 studies for bias; however, we did not use it for the Spring et al. (2009) study, because they reported only qualitative data. Of the 14 studies, 9 (64.3%) were appraised as having a "high risk" of bias, with the most common source stemming from the randomization process domain (Figueiro et al., 2015; Gibson et al., 2017; Jain et al., 2014; Paller et al., 2015; Simpson & Carter, 2010; Thomas et al., 2019). We deemed the remaining three studies as high risk due to significant concerns with measurement of the sleep outcomes (Elliott et al., 2010; Hirano et al., 2011) and intervention fidelity (Sloane et al., 2015). We categorized three studies as possessing "some concerns" due to concerns with measurement of the sleep outcome (Fowler et al., 2016; Rowe et al., 2010; Williams et al., 2019) missing sleep outcome data (Fowler et al., 2016) and the randomization process (Fowler et al., 2016). Thus, only two studies, both testing physical interventions, were deemed to possess a "low risk" of bias across all five bias domains (Table 1; Korn et al., 2009; Rose et al., 2009). This indicator of the quality of the included studies, when taken into consideration with other study characteristics such as the populations, settings, selected outcomes, and interventions, has adequate quality and an acceptable degree of bias for the critical appraisal and synthesis of the included studies.

Design Characteristics of Studies

Seven (Elliott et al., 2010; Fowler et al., 2016; Hirano et al., 2011; Korn et al., 2009; Rose et al., 2009; Rowe et al., 2010; Williams et al., 2019) of the reviewed studies tested their intervention in a two-group, randomized controlled trial (RCT). The remaining studies used quasi or nonexperimental designs. The control groups in four (Elliott et al., 2010; Fowler et al., 2016; Hirano et al., 2011; Rowe et al., 2010) of the traditional RCTs were assigned a passive control (i.e., usual care condition), while the other three received an active control (Korn et al., 2009; Williams et al., 2019) or placebo (Rose et al., 2009). Figueiro et al. (2015) used the informal caregivers as a control group for the care recipients with ADRD.

Nine studies (Elliott et al., 2010; Figueiro et al., 2015; Fowler et al., 2016; Gibson et al., 2017; Hirano et al., 2011; Jain et al., 2014; Korn et al., 2009; Paller et al., 2015; Sloane et al., 2015) used a pre/posttest design, whereas the other six studies (Rose et al., 2009; Rowe et al., 2010; Simpson & Carter, 2010; Spring et al., 2009; Thomas et al., 2019; Williams et al., 2019) used repeated measures. The studies' data collection schedules ranged from several weeks (Figueiro et al., 2015; Gibson et al., 2017; Hirano et al., 2011; Jain et al., 2014; Korn et al., 2009; Paller et al., 2015; Rose et al., 2009; Simpson & Carter, 2010; Sloane et al., 2015) to several months (Elliott et al., 2010; Fowler et al., 2016; Rowe et al., 2010; Spring et al., 2009; Thomas et al., 2019; Williams et al., 2019) Table 2 provides a summary of the included studies' methodologies.

Sample Characteristics

The majority (60%) of studies recruited participants from a single geographic area, most often a single community. However, Korn et al. (2009) recruited from four counties in the Pacific Northwest, Williams et al. (2019) recruited from two Midwest US research sites, and Elliott et al. (2010) recruited from five sites across the United States. Seven studies included caregiver/care recipient dyads (Elliott et al., 2010; Figueiro et al., 2015; Gibson et al., 2017; Paller et al., 2015; Rowe et al., 2010; Sloane et al., 2015; Williams et al., 2019), with the remaining studies studying only the informal dementia caregivers. Few studies had a sample size larger than 50, except for Williams et al. (2019) ($N = 84$) and Elliott et al. (2010) ($N = 495$). The informal caregivers were predominantly White female spouses between the approximate ages of 60 and 75 years living with and providing care for an older White male.

The most commonly evaluated sleep outcome was subjective sleep quality. The most common instrument used to measure subjective sleep quality was the Pittsburgh Sleep Quality Index (PSQI). However, Elliott et al. (2010) and Hirano et al. (2011) derived their own measure of sleep quality. Six studies also measured sleep quality objectively with actigraphy (Figueiro et al., 2015; Fowler et al., 2016; Gibson et al., 2017; Rowe et al., 2010; Simpson & Carter, 2010; Thomas et al., 2019). A small portion of the studies also measured sleep disturbance (Sateia, 2014) with investigator-derived instruments (Rowe et al., 2010), or validated subjective instruments such as the Insomnia Severity Index (Fowler et al., 2016), the General Sleep Disturbances Scale (GSDS) (Rose et al., 2009), the Medical Outcomes Study Sleep Scale (MOS-Sleep) (Sloane et al., 2015), and the Epworth Sleepiness Scale (Rowe et al., 2010). Two studies also used light meters to measure circadian stimulus, phasor angle, and phasor magnitude, which are indicative of physiologic responses to light (Figueiro et al., 2015; Sloane et al., 2015). Finally, two studies used qualitative responses to describe participant perceptions of how the intervention influenced their sleep (Gibson et al., 2017; Spring et al., 2009).

Intervention Design and Effects on Sleep Health

The described interventions varied in complexity and scope. Some interventions consisted of a single intervention component (Korn et al., 2009; Rose et al., 2009), whereas others contained multiple components (Elliott et al., 2010; Gibson et al., 2017; Simpson & Carter, 2010). Notably, only four (Korn et al., 2009; Rose et al., 2009; Spring et al., 2009; Williams et al., 2019) studies mentioned the use of a theory or framework to guide their intervention

development or implementation. Korn et al. (2009) used polarity therapy theory, Rose et al. (2009) used psychoneuroimmunology theory, Spring et al. (2009) used grounded theory, and Williams et al. (2019) used a dementia behavior model. Given the intervention heterogeneity, we derived an interventional taxonomy to organize our synthesis of the interventions and their effect on sleep. This taxonomy classifies the study interventions by four intervention functionality themes: physical, environmental, cognitive, and collaborative. All of the environmental interventions (Figueiro et al., 2015; Rowe et al., 2010; Sloane et al., 2015; Spring et al., 2009; Thomas et al., 2019), three physical interventions (Gibson et al., 2017; Hirano et al., 2011; Rose et al., 2009), and two collaborative interventions (Fowler et al., 2016; Simpson & Carter, 2010) were designed to specifically target caregiver sleep, while others used to sleep as a secondary intervention outcome (Elliott et al., 2010; Spring et al., 2009; Williams et al., 2019) See Table 3 for a detailed summary of the interventions and their effects.

Environmental Interventions.

These interventions involved either modifying or monitoring the home environment of the participants. Caregiver recipients of the Rowe et al. (2010) nighttime monitoring intervention reported significantly lower sleep after wake onset levels than controls; however, no other significant objective or subjective differences in sleep quality were observed. The Spring et al. (2009) qualitative subanalysis of the Rowe et al. (2010) study found that the use of an in-home NMS increased self-reported sleep quality in some caregivers, while others reported more nighttime awakenings because of the system's alarm. In addition, the second Thomas et al. (2019) case study explored the feasibility and preliminary efficacy of using home-based infrared motion sensors to identify digital biomarkers that may inform caregiver support. They found that the caregiver's objective sleep time decreased slightly during the monitoring period (Thomas et al., 2019). Finally, Figueiro et al.'s (2015) and Sloane et al.'s (2015) studies tested the effects of prescribed in-home light therapy. Overall, receipt of both interventions corresponded to increases in the caregivers' circadian stimulus and sleep efficiency. However, compared to controls, caregiver recipients of Sloane et al.'s (2015) light intervention reported significantly better sleep quality and fewer sleep problems, while Figueiro et al. (2015) reported no other significant sleep-related findings.

Physical Interventions.

Four studies tested physical interventions that involved some prescribed dose of physical contact or activity. For example, Korn et al.'s (2009) intervention was eight weekly polarity therapy sessions among a sample of Pacific Northwest American Indians for stress reduction. Similarly, participants in Rose et al.'s (2009) study received 60 min of daily cranial electric stimulation over the course of 4 weeks to improve sleep, depressive symptoms, and caregiver appraisal. Hirano et al. (2011) prescribed three weekly doses of moderate intensity exercise for 12 weeks to improve caregiver burden and bothersome physical symptoms. The prescribed exercise intervention was associated with a significant improvement in caregiver subjective sleep quality, whereas the polarity therapy and cranial electric stimulation interventions were not associated with significant follow-up changes in subjective sleep quality or sleep disturbance (Korn et al., 2009; Rose et al., 2009).

Interestingly, Gibson et al.'s (2017) sleep-focused intervention trialed a combination of prescribed exercise and light therapy with sleep hygiene education for caregiver study participants. While they did not perform any formal hypothesis testing, they reported a quantitative trend toward improved sleep quality in the participants, who also provided qualitative support of the intervention's beneficial impact on their sleep (Gibson et al., 2017).

Cognitive Interventions.

Three studies examined the effects of cognitive-focused interventions. These interventions were designed to reduce caregiver stress (Jain et al., 2014; Paller et al., 2015) and burden (Thomas et al., 2019). For example, Thomas et al. (2019) tested the effect of eight individual telehealth cognitive behavioral therapy sessions and three in-person caregiver group meetings within a caregiver/care recipient dyad. Alternatively, the Jain et al. (2014) and Paller et al. (2015) interventions involved attending eight weekly small group meetings that focused on the development of meditation (Jain et al., 2014) and mindfulness skills (Paller et al., 2015). The Jain et al. (2014) intervention was associated with fewer insomnia symptoms at study follow-up. Paller et al. (2015) also reported improved sleep quality among intervention recipients, yet the improvement was not significant. Thomas et al. (2019) did not perform formal statistical comparisons; however, they reported a progressive quantitative decline of the caregiver's sleep quality resulting from the demands related to the clinical deterioration of the care recipient.

Collaborative Interventions.

The final four studies employed collaborative approaches to providing caregiver support. For instance, Williams et al. (2019) provided intervention recipients with a home video recording system that was reviewed by an interprofessional team to provide education, feedback, and develop caregiving strategies for problem behaviors. However, the intervention did not demonstrate any significant effects on measured sleep outcomes. Fowler et al. (2016) deployed a virtual healthcare neighborhood whose recipients did not report significant changes in sleep quality, sleep quantity, and insomnia symptoms, compared to the control group. Elliott et al. (2010) and Simpson and Carter (2010) tested face-to-face interventions that, like Williams et al. (2019), provided education and feedback, but also included intervention elements related to goal setting and provision of social support. The Simpson and Carter (2010) intervention was focused exclusively on improving caregiver sleep, while the Elliott et al. (2010) intervention was broader in scope. Nonetheless, Simpson and Carter (2010) reported no significant interventional sleep effects, and Elliott et al. (2010) reported a significant improvement in sleep for intervention recipients over time, but the improvement was not significantly better than the control group.

Discussion

We identified four relatively distinct intervention taxonomies: physical, environmental, cognitive, and collaborative. Overall, light-based environmental interventions significantly improved circadian stimulus and sleep efficiency (Figueiro et al., 2015; Sloane et al., 2015). These findings are consistent with another systematic review of light therapy in

neuropsychiatric illness (Faulkner et al., 2020), while a monitoring-based environmental intervention was associated with a decrease in wake after sleep onset (Rowe et al., 2010). Physical interventions consisting of prescribed exercise were significantly associated with improvements in sleep latency (Gibson et al., 2017) and sleep quality (Hirano et al., 2011). This finding is unsurprising, as an abundance of evidence suggests regular physical exercise promotes sleep health (Dolezal et al., 2017). Similarly, prescribed cognitive interventions were predictive of decreased insomnia symptomatology (Jain et al., 2014) and improved sleep quality which is also an extant finding in other primary care and community settings (Cheung et al., 2019; Paller et al., 2015).

All studies in this review were longitudinal, and 7 of the 15 reported using a diverse range of quasi or nonexperimental study designs. Furthermore, apart from Elliott et al. (2010) and Williams et al. (2019) the remaining studies all had sample sizes of less than 50 participants, of which less than half studied caregiver/care recipient dyads. The sampling was relatively homogeneous, with the included studies' sample characteristics being consistent with one another and the extant literature (Brodaty & Donkin, 2009). Objective and subjective sleep quality was the most commonly evaluated outcome among the studies in this review, with a small number of studies measuring subjective symptoms of sleep disturbance (Fowler et al., 2016; Jain et al., 2014; Rowe et al., 2010; Sloan et al., 2015). However, several studies used only subjective (Elliott et al., 2010; Hirano et al., 2011; Korn et al., 2009; Paller et al., 2015; Rose et al., 2009; Williams et al., 2019) or objective (Fowler et al., 2016, Rowe et al., 2010; Sloane et al., 2015; Thomas et al., 2019) measures of sleep quality, or were scientifically limited by missing outcome data (Fowler et al., 2016; Gibson et al., 2017; Hirano et al., 2011; Jain et al., 2014). As such, the aforementioned limitations of the studies in this review curb our ability to draw confident conclusions regarding the effect of sleep interventions on the sleep health of informal caregivers of those with ADRD.

Considering the current state of the science regarding the effects of sleep interventions on the sleep health of informal caregivers of those with ADRD, we propose several recommendations for future clinical research. While heterogeneity in the study designs affirms the feasibility of conducting interventional work in this population, the future use of rigorously designed and adequately powered studies should be emphasized (e.g., RCT; Hariton & Locascio, 2018). Also, we encourage the inclusion of more diverse informal caregiver populations, as the present sampling homogeneity limits generalizability of the studies' respective findings. In addition, we recommend that any future study in this population include dyadic interventions with caregiver/care recipient dyads from varied sociodemographic backgrounds, as they are feasible to conduct, and may be particularly effective when targeting caregiver outcomes related to burden, such as sleep (Brodaty et al., 2003; Poon, 2019).

Given the varied success of interventions across taxonomies, combination of various intervention taxonomies into multicomponent, group-focused intervention delivered over several weeks may yield superior effectiveness. This recommendation is consistent with prior work related to the use of multicomponent interventions for sleep health (Murawski et al., 2018; Schlarb et al., 2010) and other dementia caregiving populations (Gilhooly et al., 2016). This recommendation provides an opportunity for clinical researchers to develop

effective interventions via scientifically rigorous means such as mixed methods designs (Gibson et al., 2017; Rowe et al., 2010; Spring et al., 2009), or advanced developmental designs like multiphase optimization strategy (MOST) or sequential multiple assignment randomized trial (SMART) designs (Collins et al., 2007). Furthermore, the limited effectiveness of the collaborative interventions further accentuates a broader sentiment among clinical scientists regarding the significance and need for the development of health promotion interventions that focus not only on education and feedback, but also incorporate biopsychosocial models of health maintenance (Collins et al., 2016; National Institute of Nursing Research, 2016; Ricon et al., 2019). Nonetheless, as the SARS-CoV-2 pandemic continues to disrupt global healthcare delivery systems and social functioning (Chakraborty & Maity, 2020; Ivanov, 2020), the feasibility of delivering remote interventions to this population is supported by the successful conduct of the collaborative studies in this review, and may be able to guide and expand upon future development of remote interventions.

Finally, the specific sleep outcome to target requires significant consideration. The National Sleep Foundation recommends joint examination of subjective and objective sleep quality measures, as well as additional indicators of sleep health (e.g., satisfaction, duration, and disturbances) and other related variables (e.g., sociodemographic factors, general health, sleep habits, sleep environment, and sleep beliefs) (Knutson et al., 2017; Ohayon et al., 2017). Therefore, we recommend clinicians and researchers design their interventions to not only target particular domains of sleep health, but also appreciate the conceptual complexity of sleep health. As such, interventions may be more effective if they possess multiple components targeting various objective and subjective domains of sleep health (Knutson et al., 2017).

Our study possessed notable limitations. To begin, we could have selected a more exhaustive search strategy, using additional terms such as "cognitive decline." Therefore, it is possible our search did not yield every existing study that met our inclusion criteria. Furthermore, our bias assessment tool was designed for evaluation of randomized trials, limiting the conclusions to be drawn from the bias assessment of nonrandomized trials in this review. Also, heterogeneity in study designs and intervention types prevented us from providing definitive conclusions regarding intervention superiority. In addition, the results from the majority of the included studies should be cautiously interpreted, as their internal validities were most likely influenced by bias. Finally, the findings of our review may not be generalizable to underrepresented caregiver/care recipient populations, such as sociodemographic minorities.

As the societal burden of ADRD exponentially increases, the need to develop effective interventions to support informal caregivers of those with ADRD is paramount (Brodaty & Donkin, 2009). Specifically, maintenance of sleep health is crucial to supporting the overall well-being of these caregivers, as well as their care recipients (Gao et al., 2019). We recommend future clinical researchers develop theoretically based and tailorable multicomponent interventions that target various domains of sleep health to inform future development and subsequent delivery of effective sleep interventions for this vulnerable population.

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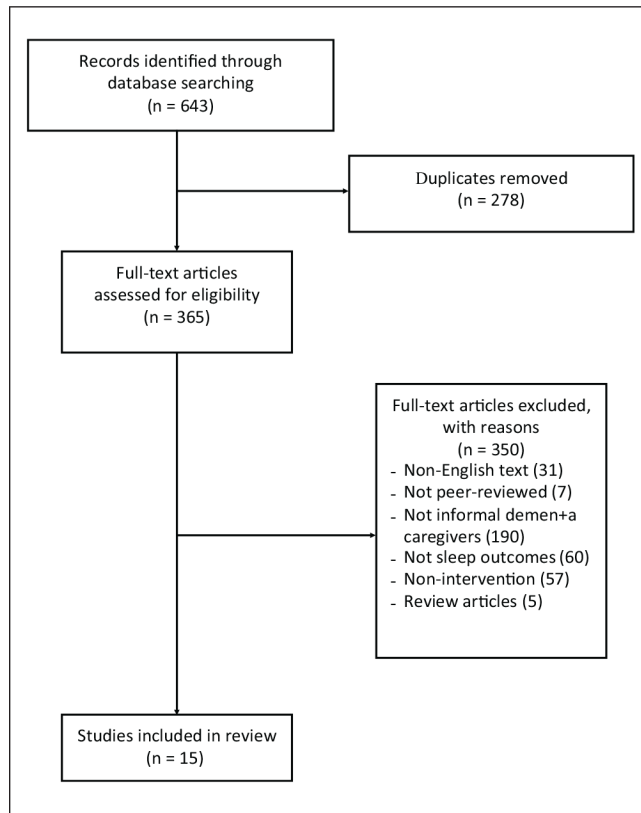
Figure 1.
PRISMA Flow Diagram for Study Selection.

Table 1.

Bias Risk Assessment of Included Studies.

Author	Randomization	Intervention Deviations	Missing Outcome Data	Outcome Measurement	Reporting Selection	Overall Risk of Bias
Elliott	Low	Low	Low	High	Low	High
Figueiro	High	Low	Low	Some concern	Low	High
Fowler	Some concern	Low	Some concern	Some concern	Low	Some concerns
Gibson	High	High	Some concern	Some concern	Low	High
Hirano	Some concern	Low	Some concern	High	Low	High
Jain	High	Low	Some concern	Low	Low	High
Korn	Low	Low	Low	Low	Low	Low
Paller	High	Low	Low	Low	Low	High
Rose	Low	Low	Low	Low	Low	Low
Rowe	Low	Low	Low	Some concern	Low	Some concerns
Simpson	High	Low	Low	Some concern	Low	High
Sloane	Low	High	Low	Some concern	Low	High
Thomas	High	Some concern	Some concern	Low	Low	High
Williams	Low	Low	Low	Some concern	Low	Some concern

Table 2.

Summary of Study Methodologies.

Authors	Design	Setting	Population
Elliott et al. (2010)	Randomized, multiple-site clinical trial	At home	Caregiver (n = 495) Age (M): 61.25 Gender (% female): 83.8 Race (% Caucasian): 32.2 Person with ADRD (n = 495) Age (M): 78.8 Gender (% female): 55.7 Race (% Caucasian): not provided
Figueiro et al. (2015)	Longtiudinal, pre/post quasi-experiment	At home	Caregiver (n = 34) Age (M):71.8 Gender (% female): not provided Race (% Caucasian): not provided Person with ADRD (n = 35) Age (M): 80.8 Gender (% female): not provided Race (% Caucasian): not provided
Fowler et al. (2016)	Randomized two-group pre/posttest design	At home	Caregiver (n = 28) Age (M): 63 Gender (% female): 46 Race (% Caucasian): 75 Person with ADRD (n = 28) Age (M): 82 Gender (% female): not provided Race (% Caucasian): not provided
Gibson et al. (2017)	Mixed methods feasibility study	At home	Caregiver (n = 15) Age (M): not provided Gender (% female): not provided Race (% Caucasian): not provided Person with ADRD (n = 15) Age (M): not provided Gender (% female): not provided Race (% Caucasian): not provided
Hirano et al. (2011)	Randomized two-group design	At home	Caregiver (n = 31) Age (M): 73.7 Gender (% female): 67.7 Race (% Caucasian): not provided Person with ADRD (n = 31) Age (M): 76.9 Gender (% female): not provided Race (% Caucasian): not provided
Jain et al. (2014)	Open label feasibility study	In person sessions at in the community	Caregiver (n = 10) Age (M): 64

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Authors	Design	Setting	Population
			Gender (% female): 100 Race (% Caucasian): 80 Person with ADRD (n = 10) Age (M): not provided Gender (% female): not provided Race (% Caucasian): not provided
Korn et al. (2009)	RCT	At home, specifically within the Native American community	Caregiver (n = 42) Age: 57% > 50 years Gender (% female): 90.5 Race (% Caucasian): 0 Person with ADRD (n = 42) Age: 57.5% are >70 Gender (% female): not provided Race (% Caucasian): 0
Paller et al. (2015)	Pre/post quasi-experimental	Medical room conference center or local senior center	Caregiver (n = 20) Age (M): 62.5 Gender (% female): 80 Race (% Caucasian): not specified Person with ADRD (n = 17) Age (M): 72.0 Gender (% female): 29 Race (% Caucasian): not provided
Rose et al. (2009)	Randomized, double-blind, controlled pilot study	At home	Caregiver (n = 38) Age (M): 74.23 Gender (% female): 65.8 Race (% Caucasian): not provided Person with ADRD (n = 38) Age (M): 76.075 Gender (% female): not provided Race (% Caucasian): not provided
Rowe et al. (2010)	Controlled clinical trial with pretest–posttest control group design and repeated measures,	At home	Caregiver (n = 45) Age (M): 62.165 Gender (% female): 81 Race (% Caucasian): 77.5 Person with ADRD (n = 45) Age (M): 79.62 Gender (% female): 50 Race (% Caucasian): not provided
Simpson and Carter (2010)	Quasi-experimental, repeated measures design	Location of caregiver's choice, usually at home	Caregiver (n =10) Age (M): 63 Gender: predominantly women Race (% Caucasian): 60 Person with ADRD (n = 10) Age (M): not provided Gender (% female): not provided Race (% Caucasian): not provided

Authors	Design	Setting	Population
Sloan et al. (2015)	Randomized control trial with crossover	At home	Caregiver (n =17) Age: 41% are >60 years Gender (% female): 77 Race (% Caucasian): 82 Person with ADRD (n = 17) Age: 65% are >80 years Gender (% female): 65 Race (% Caucasian): 82
Spring et al. (2009)	Qualitative art of a mixed methods study	At home	Caregiver (n =14) Age (M): 63 Gender (% female): 93 Race (% Caucasian): 79 Person with ADRD (n = 14) Age (M): not provided Gender (% female): not provided Race (% Caucasian): not provided
Thomas et al. (2019)	A case study of one caregiver who participated in two separate studies	At home and through telemedicine	Caregiver (n = 1) Age: 71 Gender (% female): 100 Race: not provided Person with ADRD (n = 1) Age: 74 Gender (% female): 0 Race: not provided
Williams et al. (2019)	Randomized control trial	At home	Caregiver (n = 83) Age (M): 64 Gender (% female): 71 Race (% Caucasian): 86 Person with ADRD (n = 71) Age (M): 75.7 Gender (% female): 41 Race (% Caucasian): 96

Table 3.

Summary of Study Interventions and Effects on Sleep Outcomes.

Author	Intervention (Type)	Significant Sleep Outcomes	Nonsignificant Sleep Outcomes
Elliott et al. (2010)	REACH (collaborative), a multicomponent individualized intervention including educational materials for caregivers about self-care and health, and a telephone support group session.	Caregiver sleep quality (self-reported) improved in intervention group	None
Figueiro et al. (2015)	Lighting intervention (environmental) in which custom luminaires were installed into participants' homes.	None	- Sleep duration (actigraphy): decreased insignificantly - Sleep minutes (actigraphy): decreased insignificantly - Sleep efficiency - PSQI global score (self-reported) decreased insignificantly
Fowler et al. (2016)	Virtual Healthcare Neighborhood (VHN; collaborative), a website that includes a blog for social support, educational material, and the opportunity to ask questions to an interdisciplinary healthcare team.	None	- Insomnia severity (self-reported) - Number of sleep interruptions (actigraphy) decreased insignificantly - Sleep score (actigraphy) improved insignificantly
Gibson et al. (2017)	Bright light therapy, exercise, and sleep hygiene education (physical).	Not provided	Not provided
Hirano et al. (2011)	Regular exercise of moderate intensity (physical).	- Quality of sleep scores decreased (self-reported)	None
Jain et al. (2014)	Central Meditation and Imagery Therapy for Caregivers (CMIT-C; cognitive), an in-person meditation and guided imagery group therapy program.	- Decreased insomnia symptoms	None
Korn et al. (2009)	Polarity therapy (physical), a type of biofield touch therapy where a practitioner strategically applies manual pressure to different anatomical points.	None	- Quality and patterns of sleep (self-reported)
Paller et al. (2015)	Mindfulness (cognitive) group sessions with elements drawn from dialectical behavioral therapy and from acceptance and commitment therapy.	- Among the participants who registered sleep problems initially, there was a significant improvement in sleep quality	None
Rose et al. (2009)	Cranial Electrical Stimulation, (CEM; physical) using a small device, which attaches using clips on the earlobes, that delivers low levels of alternating electrical current to the head.	- Decreased sleep onset latency (self-reported)	- Sleep disturbances (self-reported) - Sleep quality (self-reported)
Rowe et al. (2010)	Nighttime Monitoring System, (NMS; environmental), a device which alerts the caregiver when the care-recipient leaves their bed at night.	- Subjective improved sleep (self-reported)	- Objective sleep (actigraphy)
Simpson and Carter (2010)	Caregiver Sleep Intervention, (CASI; collaborative), a behavioral intervention incorporating stimulus control, relaxation therapy, cognitive therapy, sleep hygiene education, and goal setting and attainment.	None	- Sleep quality (self-reported) - Objective sleep measurement (actigraphy)
Sloan et al. (2015)	Blue–white light therapy (environmental) installed on during individuals' normal waking hours. Control group was given yellow–white light.	Compared to control lighting: - Improved sleep efficiency (self-reported) - Improved sleep adequacy (self-reported) - Decreased sleep problems (self-reported) - Improved sleep index score (self-evaluated) Compared to usual light: - Decreased sleep problems (self-reported)	None

Author	Intervention (Type)	Significant Sleep Outcomes	Nonsignificant Sleep Outcomes
		- Decreased sleep disturbances (self-reported) - Improved sleep index score (self-evaluated)	
Spring et al. (2009)	NMS (environmental), which tracks the nighttime activities of the care recipient and both alerts the caregiver and allows the caregiver to track the recipient's movements.	- Increased sleep disruptions affecting quality and quantity of sleep (self-reported)	None
Thomas et al. (2019)	Tele-STAR (cognitive, cognitive), telehealth consultations to discuss distressing care recipient behavior, and EVALUATE-AD (environmental), a motion sensor computer system that monitors caregiver behavior and burden.	- Decreased total sleep time (motion sensors)	None
Williams et al. (2019)	Supporting Family Caregivers with Technology for Dementia Home Care, FamTechCare (collaborative), a telehealth and technology intervention involving video cameras at home recording difficult situations and then tailored interventions based on those recordings made by an interdisciplinary team of experts.	None	- Sleep disturbance (self-reported)