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Title: Sleep hygiene education as a treatment of insomnia: A systematic review and meta-analysis

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Name of authors: Ka-Fai Chung [1]

Chit-Tat Lee [2]

Wing-Fai Yeung [3]

Man-Sum Chan [2]

Emily Wing-Yue Chung [4]

Wai-Ling Lin [5]

Affiliation: [1] Department of Psychiatry, University of Hong Kong, Hong Kong SAR, China; [2] Department of Psychiatry, Queen Mary Hospital, Hong Kong SAR, China; [3] School of Nursing, Hong Kong Polytechnic University, Hong Kong SAR, China; [4] Chinese University of Hong Kong, Hong Kong SAR, China; [5] Hong Kong Institute of Integrative Medicine, Chinese University of Hong Kong, Hong Kong SAR, China.

***Correspondence**: Dr. K.F. Chung; Department of Psychiatry, University of Hong Kong, Pokfulam, Hong Kong SAR, China. Telephone: 852-22554487, Fax: 852-28551345, E-mail: kfchung@hku.hk

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3 Tables, 1 Figure

Abstract

Background: Sleep hygiene education (SHE) as a treatment of insomnia in the primary care setting is controversial. Whether SHE or cognitive-behavioral therapy for insomnia (CBT-I), a treatment with stronger evidence base, should be provided first remains unclear.

Objective: To review the efficacy of SHE for poor sleep or insomnia.

Methods: We systematically searched 6 key electronic databases up until June 2015. Two researchers independently selected relevant publications, extracted data, and evaluated methodological quality according to the Cochrane criteria.

Results: Thirteen randomized controlled trials with SHE alone as a treatment arm were found. Ten of the 13 included studies compared SHE with CBT-I, 3 studies with mindfulness-based therapy, but none with sham or no treatment. General knowledge about sleep, substance use, regular exercise, and bedroom arrangement were covered, but sleep-wake regularity, avoidance of daytime naps, and stress management was only included in 3 programs. The major findings include: 1) there were significant pre- to post-treatment improvements following SHE, with small to large effect size; 2) SHE was significantly less efficacious than CBT-I, with difference in effect size ranging from small to medium; 3) pre- to post-treatment improvements and SHE-CBT-I differences were limited to subjective measures; and 4) no data on acceptability, adherence, understanding, and cost-effectiveness.

Conclusions: Although SHE is less effective than CBT-I, unanswered methodological and implementation issues disallow a firm conclusion whether SHE has a role in a

stepped-care model for insomnia in the primary care. Future studies should adopt a standardized and comprehensive SHE package.

Keywords: Sleep hygiene education; Cognitive-behavioral therapy; Psychological intervention; Systematic review; Meta-analysis; Insomnia

Background

Insomnia is a highly prevalent condition that is associated with substantial distress, psychosocial impairment, and medical and psychiatric morbidity.[1] General practitioners are consulted more frequently than other health professionals for sleep problems.[2] Patients typically prefer non-pharmacological treatments,[3] and sleep hygiene education (SHE) is the most commonly used strategy for sleep problems in general practice.[4]

The term “sleep hygiene” was first used by Peter Hauri in 1977 in the context of providing recommendations for patients with insomnia.[5,6] The list of sleep hygiene recommendations was updated by Hauri in 1992,[5] thereafter by other people, and many versions of recommendations are now available.[7] In a recent review by Irish et al.,[8] the authors reported that caffeine, tobacco and alcohol use, exercise, stress, noise, sleep timing, and daytime napping are the areas commonly covered during SHE. Besides the availability of many versions of SHE, another controversy is its effectiveness for treating insomnia. A recent review paper published in the American Family Physician[9] placed SHE equivalent to cognitive-behavioral therapy for insomnia (CBT-I), while the American Academy of Sleep Medicine Report in 2006[10] and a clinical guideline published in the Journal of Clinical Sleep Medicine in 2008[11] did not support SHE as a single therapy due to insufficient evidence. Several clinical guidelines, such as the National Health Service in England[12] and the Toward Optimized Practice Program in Canada,[13] recommend SHE as a first step while CBT-I as a second step for treating insomnia.

To our knowledge, there is no previous systematic review on SHE as a treatment of insomnia. The last review on SHE was published in 2003 and limited to

selective literature review.[7] Since SHE is commonly used in healthcare settings and many studies may have been published on SHE, the aim of this systematic review and meta-analysis is to provide a precise summary of the efficacy of SHE, compared to conventional therapies, no treatment, and other forms of treatments for insomnia.

Method

Literature search

The meta-analysis was conducted with reference to the preferred reporting items for systematic review and meta-analyses (PRISMA).[14] The protocol was registered at the International prospective register of systematic reviews (CRD42015024995). The MEDLINE, EMBASE, CINAHL plus, PsycINFO, and Dissertation & Thesis A&I and Cochrane Library from inception through 30 June 2015 were searched without language restriction using the search terms: (sleep hygiene OR sleep education OR sleep health) AND (random* OR controlled trial OR clinical trial OR RCT) AND (sleep OR insomnia OR dyssomnia) in titles or abstracts. Reference lists of the included studies and relevant reviews were examined for additional articles. As a forward search, we used the MEDLINE to identify all papers that have cited the included studies.

Study selection

Studies included in this review are randomized controlled trials that fulfilled the following criteria:

Type of participants: we included studies of subjects with a complaint of poor sleep or insomnia.

Type of intervention: we included studies examined SHE w as a treatment or comparison. SHE was defined as any advice provided to patients with an intention to help their sleep but without any of CBT-I (including stimulus control, sleep restriction, relaxation training, and cognitive therapy) and complementary and alternative medicine components (e.g. Taichi, qigong, massage, acupressure, etc.). We did not set any specifications for delivery modality, treatment content and duration.

Types of comparison: We included studies compared SHE with no treatment, routine care, placebo or sham treatment, or any forms of psychological or pharmacological or complementary and alternative medicine treatment.

Type of outcome measures: We did not set any specifications for outcomes. We would assess sleep outcome such as sleep questionnaire, sleep diary, objective actigraphy or polysomnography.

Two investigators selected relevant publications independently according to the eligibility criteria. Any disagreement was resolved by thorough discussion and consultation with the senior author (KC). When a study had more than one patient group (e.g. one group of primary insomnia and another group of comorbid insomnia), we considered it twice as 2 different comparisons. When the same group of authors published more than 1 article using data from the same group of subjects, we considered it as 1 set of comparison and used the largest dataset that was available.

Data extraction and quality assessment

One investigator extracted the data and another checked the extracted data. For each study, the following variables were extracted: study design, subjects' characteristics including age, gender, duration and diagnosis of insomnia, components

and procedure of SHE, comparison intervention, and outcome parameters. Primary outcome was sleep questionnaire score, but other outcomes, such as sleep diary, actigraphy, and polysomnography-derived variables were also recorded if available. We analyzed the quality of studies using the Cochrane's risks of bias assessment,[16] which has 6 domains: random sequence generation, allocation concealment, blinding of participants, personnel, and outcome assessors, incomplete outcome data, selective outcome reporting, and other sources of bias. The ratings of each domain can be 'yes' (low risk of bias), 'no' (high risk of bias) or 'unclear' (uncertain risk).

Data synthesis and analysis

We used the Comprehensive meta-analysis software version 3.0 for statistical analysis. The summary measure was the effect size, calculated as Hedges's g and its 95% confidence interval (CI). We analyzed the pre- to post-treatment improvements and between-group differences in outcomes. Due to differences in demographic characteristics and inclusion and exclusion criteria between studies, it was expected that there was heterogeneity a priori; hence the random-effects model and inverse-variance method were employed to calculate summary estimates.[15] Heterogeneity was evaluated using the Cochrane's Q statistic, with p-value less than 0.10 indicating significant heterogeneity.[16] The I^2 statistic was computed as a compliment to the Q statistic. As suggested by Higgins et al.,[17] I^2 of 0%, 25%, 50%, and 75% indicate no, low, moderate, and high heterogeneity, respectively. If there were at least 10 studies in the same comparison, publication bias would be examined by visual inspection of the funnel plot, which is a scatterplot of treatment effect against sample size. Sensitivity analysis was performed using the leave-one-out method in order to investigate the influence of outlying studies on the synthesized effect size in the random-effects model.[18] We used the GRADE system to assess the overall quality of

the evidence for all prespecified outcomes. The Grading of Recommendation, Assessment, Development and Evaluation Working Group (GRADE) developed a system for grading the quality of evidence that takes into account issues related to both internal and external validity, including study limitations, consistency of effect, imprecision, indirectness, and publication bias (Guyatt 2008). We used methods and recommendations described in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2011). The evidence was graded as high, moderate, low or very low. We justified all decisions to down- or upgrade the quality of studies using footnotes.

Results

Identification of studies

Fig. 1 presents the flowchart of the systematic review. A total of 1981 entries were included for title and abstract screening and 126 papers were selected for full-text screening. Thirteen studies met the eligibility criteria and were included in this review.[19-31] Full details of the excluded studies are available from the authors upon request.

Overview of the included studies

Table 1 summarizes the characteristics of the 13 included studies. These studies were conducted in the U.S., China, Japan, New Zealand, Norway and Spain. Sample sizes ranged from 20 to 155, with a total of 956 subjects. About 60.9% were female and the mean age was 52.1 years. Twelve of the 13 studies were 2-arm studies and the other was a 3-arm study. CBT-I was the most common comparator (n = 10), followed by mindfulness-based study (n = 3), while no studies compared SHE with

placebo or sham treatment, treatment as usual, complementary and alternative medicine therapy, or no treatment. The criteria used for diagnosis of insomnia varied between studies. Three of the 13 included studies used the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) or International Classification of Sleep Disorders (ICSD) criteria; 3 studies used sleep-diary-derived sleep onset latency (SOL) or wake after sleep onset (WASO) ≥30 minutes for ≥3 nights per week as inclusion criteria, while 2 studies recruited subjects with a Pittsburg Sleep Quality Index (PSQI) score ≥5. There were also great differences in subject characteristics. Two studies examined adults ≥65 years and 1 study only included subjects aged >55 years, while 2 studies were on cancer survivors, 1 on university students, and 1 on patients with fibromyalgia. The most common outcome measure was PSQI, followed by sleep diary variables. Three studies used actigraphy but only 1 study used polysomnography.

Description of SHE

The number of sessions of SHE ranged from 1-6, with a median of 3 sessions. Six studies used group approach, 3 studies used individualized approach, 2 studies used printed materials, and 2 studies did not report the delivery modality. General knowledge about sleep architecture, substance use, regular exercise, and bedroom arrangement were commonly covered during SHE, while sleep-wake regularity, avoidance of daytime naps, and stress management were covered in 3 programs. Nine studies mentioned the use of a standardized manual, 10 studies provided therapist training, 8 studies had therapist supervision, and 5 studies had treatment fidelity monitoring.

Assessment by the Cochrane's risk of bias assessment

Results are shown in Table 2. Blinding of participants and personnel was most difficult, with 10 of the 13 studies having a high risk of bias. Allocation concealment was unclear in 12 of the 13 studies, while blinding of outcome assessors was unclear in 8 of the 13 studies. The risk of bias due to incomplete or selective outcome reporting and other sources of bias were low in all studies, except the study by Dawson et al.[31]

Efficacy assessment

Within-group difference. Table 3 presents a summary of the within-group meta-analyses on subjective and objective measures. Other than Insomnia Severity Index (ISI) total score, there was no significant heterogeneity between studies. There were significant pre- to post-treatment improvements in sleep-diary-derived SOL, WASO, sleep efficiency (SE), PSQI, and ISI. The within-group effect size was small to medium for sleep diary variables (0.28-0.40), medium for PSQI (0.47) and large for ISI (1.02). The pre- to post-treatment difference in actigraphy variables was not significant. The leave-one-out sensitivity analysis found that the significant finding in ISI was still present when an outlying study was removed. Funnel plot was not performed due to the small number of studies.

Between-group difference. Pooled analyses showed that CBT-I was significantly more effective than SHE in terms of sleep-diary-derived SOL, WASO, and SE, PSQI, and ISI, but no significant difference in actigraphy measures (Table 2). There were significant heterogeneities between studies in SOL, SE and PSQI, but the significant findings were still present when outlying studies were removed. The between-group effect size was small to medium for sleep-diary-derived SOL, WASO, and SE (0.38-0.53) and medium for PSQI and ISI (both 0.56). Pooled analyses also found that mindfulness-based therapy produced greater improvement in PSQI than

SHE, but only 2 studies were available for analysis (Hedges's g = 1.13, CI = 0.64, 1.62, $p < 0.001$).

Discussion

Our study showed that SHE was associated with sleep improvements, based on the significant pre- to post-treatment changes, but it was less effective than CBT-I and mindfulness-based therapy. Within-group improvements and between-group differences were shown using subjective measures; however, there were no significant differences in actigraphy variables. Subgroup analysis such as age effect on treatment response was not possible as none of the studies included only young adults or adolescents. Furthermore, no studies compared SHE with placebo intervention or no treatment, thus whether the within-group improvements in SHE were due to a placebo effect or a natural course and changes over time was unclear. The overall findings seem to support the American Academy of Sleep Medicine Report 2006[10] that CBT-I should be a preferred treatment for insomnia compared to SHE. However, there are unanswered methodological issues in the studies comparing SHE and CBT-I and practical problems regarding the implementation of CBT-I in the primary care setting; hence the role of SHE as a first-step treatment of insomnia remains unclear.

SHE was shown to have a small to medium pre- to post-treatment effect size on sleep diary measures (0.28 to 0.40) and a medium to large effect size on self-report sleep questionnaires (0.47 to 1.02). A previous systematic review found that psychological placebo in the form of sham procedures had no significant effects on sleep diary measures (pre-post effect size ranging from 0.12 to 0.36) and only subjective sleep quality had significant improvement (effect size 0.52).[32] Although SHE

was associated with significant improvements, head-to-head comparison with psychological placebo should be performed to examine whether SHE possesses specific therapeutic components.

Compared to CBT-I, SHE was shown to be significantly less efficacious. Although heterogeneities were present between studies, removal of outlying studies did not affect the significant results. The difference in efficacy was small to medium, depending on the outcome measures. A recent meta-analysis on psychological treatment of depression showed that smaller effect size was seen when the control interventions used standardized manuals and had therapist training, supervision, and treatment fidelity monitoring.[33] Although most of the included studies on SHE used standardized manuals and had therapist training and supervision, only 5 studies had treatment fidelity monitoring. As to the coverage of sleep hygiene recommendations, only 3 studies' SHE were comprehensive and included sleep-wake regularity, avoidance of daytime naps, and stress management. It remains unclear whether the efficacy of SHE can be enhanced by treatment fidelity monitoring and a more comprehensive coverage of sleep hygiene recommendations. In addition, there was no significant difference between CBT-I and SHE in objective outcome measures and there were risks of bias in the reviewed controlled trials; hence the benefits of CBT-I over SHE are not definitive.

A stepped-care model has been proposed by Espie as a solution to the high demand of CBT-I services.[34] The model is often conceptualized as a pyramid, of which high patient volume is managed at the base of the pyramid using low intensity treatments, with progressively smaller volumes, and greater expertise in assessment and treatment, being concentrated towards the top step. Espie recommended self-help CBT-I as the entry-step treatment. Although self-help CBT-I has a strong

evidence base for its effectiveness,[35] it contains more information and may be harder to understand than sleep hygiene recommendations. If SHE is introduced as an entry step of the stepped-care model, a standardized and comprehensive SHE package should be developed, instead of an information leaflet alone. More studies are needed to examine patients' acceptability, adherence, and understanding of CBT-I compared to SHE. Due to differences in therapists' expertise and training requirement for the implementation of CBT-I and SHE, studies should compare implementation and acceptability issues in the primary care setting and cost-effectiveness between the 2 treatments. A qualitative study suggested that although general practitioners knew about CBT-I, they seldom referred patients for treatment.[36] Based on the current literature, no definite conclusion can be made regarding whether CBT-I or SHE should be provided as a first-step treatment for insomnia in the primary care setting.

Cross-sectional studies on sleep hygiene practices have revealed 2 consistent findings. First, only daytime napping, smoking, alcohol use, and uncomfortable sleeping environment are more common in individuals with insomnia, compared to good sleepers, and the frequencies of these behaviors are not high.[11,37] Another consistent finding is that poor sleep hygiene may be more apparent in college students as class schedules are irregular, alcohol and substance use is common, and there is more freedom to engage in social activities.[38] The findings may explain why SHE may not be a sufficient treatment and having poor sleep hygiene may be a prerequisite for using SHE. Future studies should explore patient selection issues in the use of SHE for insomnia.

Major limitations of our review were the small number of studies and a lack of studies comparing SHE with placebo treatment, no treatment, treatment as usual, or waitlist control. Also, we did not know whether there were any impacts of patients'

sociodemographic characteristics, prior sleep treatment, sleep knowledge, and sleep hygiene practices on the efficacy of SHE. Methodological quality of the included studies was fair. Due to the nature of intervention, blinding of participants and personnel and allocation concealment were difficult in most studies; however, publication bias was unlikely because SHE was often used as a control intervention and the results were mostly consistent across studies.

In conclusion, SHE resulted in pre- to post-treatment improvements in sleep; however, it fared worse than CBT-I and mindfulness-based therapy for the treatment of insomnia. Both within-group and between-group differences were limited to subjective measures, while no significant change in actigraphy measures were found. Although CBT-I remains a preferred treatment, more studies are needed to examine whether SHE is better than CBT-I in terms of acceptability, adherence, understanding, and the cost and ease of implementation in the primary care setting. To understand the effectiveness of SHE, future studies should ensure treatment fidelity and a comprehensive coverage of sleep hygiene recommendations. In addition, studies comparing SHE with placebo treatments are needed.

Authors' contribution

KC designed the study and wrote the manuscript. CL and EC performed search, review and data extraction. MC performed the statistical analysis and wrote the manuscript. WY and WL performed quality assessment.

Conflict of interest

All authors, Ka-Fai Chung, Chit-Tat Lee, Wing-Fai Yeung, Man-Sum Chan, Emily Wing-Yue Chung and Wai-Ling Lin declared that there is no conflict of interest.

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Figure 1

Flow diagram of study selection

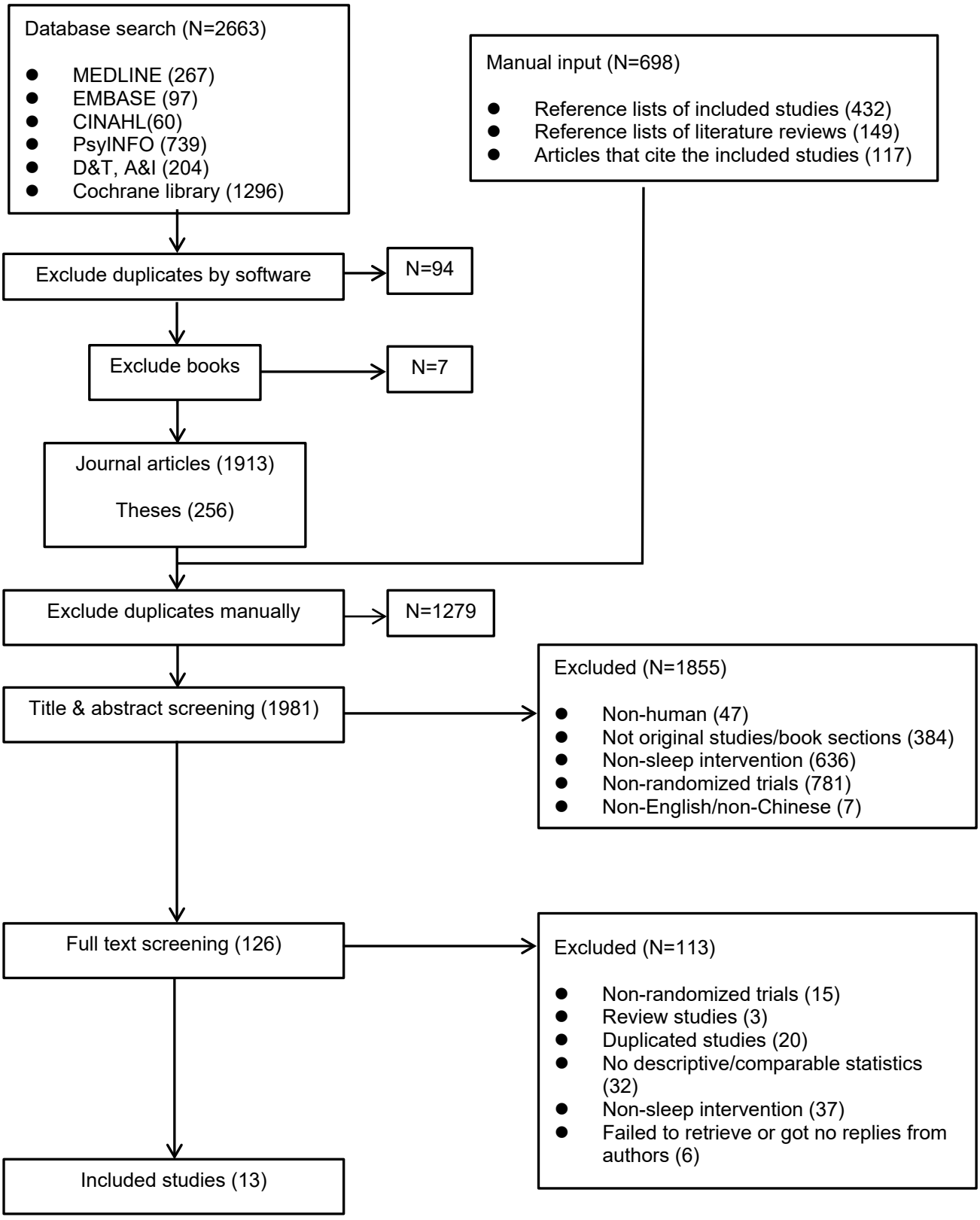

Table 1

Randomized controlled trials of sleep hygiene education for insomnia.

Author, year	Country/ type of participants	Mean age, yr (range or SD)/ % female	Diagnostic criteria	Design	Treatment duration	Post-treatment follow-up	Sample size (subgroup)	No. of sessions components/ medium o delivery	Sleep measures	Results reported
Bjorvatn et al., 2011	Norway/ insomnia > 6 mo	50.0 (NR)/ 58%	BIS	2-parallel arms (CBT-I; SHE)	3 mo	3 mo	155 (77/78)	CBT-I: NR/ SR, SC, CT, Rel & SEd/ NR SHE: NR/ SU, Ex, BR & SEd/ NR	BIS, PSQI, DBAS, use of hypnotics	CBT-I sig < BIS, PSQI & DBAS than SHE. No sig diff in use of hypnotics.
Black et al., 2015	USA/ > 55 yr with sleep disturbance	66.3 (7.4)/ 67%	PSQI >5	2-parallel arms (MAP; SHE)	6 wk	10 wk	49 (24/25)	MAP: 6/ mindfulness exercise/ gp SHE: 6/ SM, SWreg & SEd/ gp	PSQI, AIS	MAP sig < PSQI & AIS than SHE.
Dawson et al., 2014	USA/ adults with insomnia	53.6 (14.7)/ 68%	NR	2-parallel arms (CBT-I; SHE)	4 wk	Immed & 3 mo	87 (41/46)	CBT-I: 4/ NR/ gp SHE: 4/ NR/ NR	ISI, ICS, SE	CBT-I sig < ISI, ICS & > SE than SHE.
Epstein et al., 2007	USA/ breast cancer with sleep complaints > 3 mo	58.2 (29-86, SD: 10.2)/ 100%	SOL/ WASO ≥ 30 min for ≥ 3 nights/wk	2-parallel arms (CBT-I; SHE)	6 wk	2 wk	72 (34/38)	CBT-I: 4/ SR, SC & SHE/ gp SHE: 4/ SEd/ gp	ISI, Sd, actig	CBT-I sig > TIB-Sd than SHE. No sig diff in ISI, SOL-Sd, WASO-Sd, TST-Sd & TIB-actig.

Table 1 *(Continued)*

Author, year	Country/ type of participants	Mean age, yr (range or SD)/ % female	Diagnostic criteria	Design	Treatment duration	Post-treatment follow-up	Sample size (subgroup)	No. of sessions components/ medium o delivery	Sleep measures	Results reported
Edinger et al., 2009	USA/ PI & CMI	PI: 54.2 (13.7)/ 12.5% CMI: 54.2 (13.7)/ 14.6%	RDC & DSM-IV	2-parallel arms (CBT-I; SHE)	8 wk	Immed & 6 mo	PI: 40 (20/20) CMI: 41 (21/20)	CBT-I: 4/ SEd, SC & SR/ indiv SHE: 4/ SU, Ex, BR & SEd/ indiv	PSQI, DBAS, Sd, actig	PI: CBT-I sig < SOL-Sd, WASO-Sd & > SE-Sd, TST-Sd at immed post tx & < WASO-Sd & > TST-Sd at 6 mo than SHE CMI: CBT-I sig < SOL-Sd, WASO-Sd & > TST-Sd, SE-Sd at immed post tx & < WASO-Sd, WASO-actig & > TST-Sd at 6 mo than SHE.
Falloon et al., 2015	New Zealand/ 16-75 yr with PI > 6 mo	53.5 (NR)/ 77.3%	Sleep disturbance > 3 nights/wk	2-parallel arms (SSR+SHE; SHE)	2 wk	3 & 6 mo	97 (46/51)	SSR: 2/ STreg & SR/ NR SHE: 2/ SU & SM/ NR	PSQI, ISI, ESS, Sd, actig	SSR+SHE sig < PSQI, ISI & > SE-actig than SHE.
Gellis et al., 2013	USA/ university students >18 yr	NR (NR)/ 64.7%	ISI ≥ 8 & WASO/ SOL/ EMA > 30 min ≥ 3 nights/wk >1 mo	2-parallel arms (CRT+SHE; SHE)	NR	1 mo	51 (27/24)	CRT: 1/ identify thoughts & control attention/ indiv SHE: 1/ SU, Ex, BR & SWreg/ indiv	ISI	CRT-I+SHE sig > ISI than SHE

Table 1 *(Continued)*

Author, year	Country/ type of participants	Mean age, yr (range or SD)/ % female	Diagnostic criteria	Design	Treatment duration	Post-treatment follow-up	Sample size (subgroup)	No. of sessions components/ medium o delivery	Sleep measures	Results reported
Martinez et al., 2014	Spain/ 25-60 yr with fibromyalgia	47.6 (6.8)/ 100%	DSM-IV	2-parallel arms (CBT-I; SHE)	6 wk	Immed, 3 & 6 mo	59 (30/29)	CBT-I: 6/ SHE, SR, SC, CT & Rel/ gp SHE: 6/ SU, Ex, BR, SEd/ gp	PSQI	CBT-I sig < PSQI at immed post tx & 3 mo than SHE.
McCrae et al., 2007	USA/ ≥ 65 yr	77.2 (8.0)/ 65%	ICSD & DSM-IV SOL/ WASO ≥ 31 min ≥ 3 nights/wk > 6 mo	2-parallel arms (MBT; SHE)	2 wk	2 wk	20 (11/9)	MBT: 2/ SC & SR/ indiv SHE: 2/ SU, Ex, SEd/ indiv	Sd	MBT sig < SOL-Sd & > SE-Sd than SHE.
Nakamura et al., 2013	USA/ adults with cancer	MBB: 55.4 (NR)/ 68.4% MM: 50.8 (NR)/ 80% SHE: 51.6 (NR)/ 77.8%	MOS-SS ≥ 35	3-parallel arms (MBB; MM; SHE)	3 wk	Immed & 2 mo	57 (19/20/18)	MBB: 3/ mind-body exercise/ gp MM: 3/ meditation/ gp SHE: 3/ SU, Ex, SM, BM & SWreg/ gp	MOS-SS	MBB and MM sig < MOS-SS than SHE.
Nishinoue et al., 2012	Japan/ office workers	31.3 (7.1)/ 14.2%	PSQI ≥ 6 in 62.2% of subjects	2-parallel arms (MBT+SHE; SHE)	1 wk	3 mo	127 (62/65	MBT: 1/ Rel, SC & SR/ indiv SHE: 1/ SU, Ex, SM, BR, SWreg, & SEd/ gp	PSQI	MBT+SHE sig < PSQI than SHE.

Table 1 *(Continued)*

Author, year	Country/ type of participants	Mean age, yr (range or SD)/ % female	Diagnostic criteria	Design	Treatment duration	Post-treatment follow-up	Sample size (subgroup)	No. of sessions components/ medium o delivery	Sleep measures	Results reported
Sun et al., 2013	China/ ≥ 65 yr	69.7 (8.0)/ 74.7%	PSQI > 5	2-parallel arms (Rel+SHE; SHE)	4 wk	3, 6 & 12 mo	75 (37/38)	Rel: 4/ Rel & meditation/ gp SHE: NR/ NR/ indiv	PSQI, ESS	Rel+SHE sig < PSQI & ESS than SHE.
Waters et al., 2003	USA/ 18-59 yr	45.6 (NR)/ 79.3%	SOL/ WASO > 30 min or awake > 10 min > 3 times /night ≥ 4 nights/wk > 1 mo	2-parallel arms (CBT-I; SHE)	2 wk	Immed	26 (10/16)	CBT-I: 3/ SHE, CT, SR, SC & Rel/ NR SHE: 3/ SU, Ex, BR & SWreg/ NR	PSG, Sd	CBT-I sig < SOL-Sd, WASO-Sd & > sleep quality than SHE.

Abbreviations: <: shortened or reduced; >: increased or lengthened; actig: actigraphy; AIS: Athens insomnia scale; BIS: Bergen insomnia scale; BR: bedroom arrangement; CBT-I: cognitive behavioral therapy for insomnia; CMI: comorbid insomnia and psychiatric disorders; CRT: cognitive refocusing treatment; CT: cognitive therapy; DBAS: dysfunctional belief and attitudes about sleep scale; diff: difference; DSM: diagnostic and statistical manual of mental disorders; ESS: Epworth sleepiness scale; Ex: exercise; gp: group; ICS: insomnia symptom composite scale; ICSD: international classification of sleep disorders; indiv: individual; immed: immediate; ISI: insomnia severity index; MAP: mindful awareness practice; MBB: mind body bridging program; MBT: multicomponent behavioral treatment; MM: mindfulness meditation; MOS-SS: medical outcome study sleep scale; NR: not reported; PI: primary insomnia;: PSG: Polysomnography; PSQI: Pittsburg sleep quality index; Rel: relaxation training; SC: stimulus control; Sd: sleep diary; SE: sleep efficiency; SEd: sleep education; SHE: sleep hygiene education; sig: significant; SM: stress management; SOL: sleep onset latency; SR: sleep restriction; SSR: simplified sleep restriction; SWreg: sleep-wake regularity; SU: substance use; TIB: time in bed; TST: total sleep time; WASO: wake after sleep onset

Table 2

Risks of bias of the included trials using Cochrane's criteria.

Author, year	Random sequence generation	Allocation concealment	Blinding of participant and personnel	Blinding of outcome assessors	Incomplete outcome data addressed	Selective outcome reporting	Other sources of bias
Bjorvatn et al., 2011	Unclear	Unclear	High	Unclear	Low	Low	Low
Dawson et al., 2014	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Epstein et al., 2007	Low	Unclear	High	Low	Low	Low	Low
Edinger et al., 2009	Unclear	Unclear	Low	Low	Low	Low	Low
Falloon et al., 2015	Low	Low	Low	High	Low	Low	Low
Gellis et al., 2013	Low	Unclear	High	Unclear	Low	Low	Low
Martinez et al., 2014	Low	Unclear	High	Low	Low	Low	Low
McCrae et al., 2007	Unclear	Unclear	High	Unclear	Low	Low	Low
Nakamura et al., 2013	Low	Unclear	High	Unclear	Low	Low	Low
Nishinoue et al., 2012	Unclear	Unclear	High	Unclear	Low	Low	Low
Sun et al., 2013	Low	Unclear	High	Unclear	Low	Low	Low
Waters et al., 2003	Unclear	Unclear	High	Unclear	Low	Low	Low

Table 3

Summary of within-group and between-group meta-analyses of sleep hygiene education

	No. of datasets	Hedges's g	CI	Q	I^2	Hedges's g	CI	Q	I^2
		Within-group meta-analyses				Between-group meta-analyses: SHE vs. CBT-I			
Sleep diary and questionnaires									
Sleep onset latency	6	0.28**	0.07, 0.49	4.75	0.00	0.44*	0.06, 0.81	10.44	52.13
Wake after sleep onset	6	0.35**	0.14, 0.56	2.84	0.00	0.38**	0.13, 0.62	2.85	0.00
Total sleep time	4	0.29	-0.01, 0.60	4.45	32.62	0.10	-0.18, 0.37	0.11	0.00
Sleep efficiency	4	0.40**	0.16, 0.64	1.92	0.00	0.53*	0.04, 1.01	7.51	60.08
Pittsburgh sleep quality index	7	0.47***	0.31, 0.62	4.96	0.00	0.56***	0.26, 0.85	15.77	61.96
Insomnia severity index	3	1.02***	0.56, 1.49	5.67	64.73	0.56***	0.30, 0.83	0.24	0.00
Actigraphy									
Sleep onset latency	3	0.09	-0.14, 0.33	0.12	0.00	0.24	-0.05, 0.53	0.82	0.00
Wake after sleep onset	3	0.03	-0.21, 0.26	0.05	0.00	0.22	-0.21, 0.52	1.61	0.00
Total sleep time	3	0.10	-0.15, 0.34	0.11	0.00	0.10	-0.07, 0.39	0.07	0.00
Sleep efficiency	3	0.07	-0.17, 0.31	0.006	0.00	0.26	-0.03, 0.55	0.58	0.00

* P <0.05, ** p < 0.01, *** p < 0.001. CBT-I, cognitive-behavioral therapy for insomnia; SHE, sleep hygiene education