



Systematic review

Does flotation-rest (restricted environmental stimulation technique) have an effect on sleep?

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ABSTRACT

Introduction: Some therapies described within alternative and complementary medicine are advertised as sleep-promoting, including flotation-REST (Restricted Environmental Stimulation Technique). Flotation-REST induces deep relaxation through sensory isolation in a water-filled tank and is plausibly reported to mitigate insomnia problems, which have consistently been associated with stress, worry and arousal. However, the effects of flotation-REST have not been previously summarised. The aim of this systematic review was to investigate the efficacy of flotation-REST on sleep in clinical and non-clinical samples.

Methods: A systematic search for studies on flotation-REST, involving at least one sleep-related variable, was conducted in the databases PubMed, Google Scholar, Web of Science and PsychINFO. Thirteen full-text articles met the inclusion criteria and were considered for eligibility. Nine were included in the current review. The methodological quality of the studies was assessed using a structured checklist, and a standard data extraction sheet was used to summarize the ratings.

Results: In all included studies, flotation-REST demonstrated beneficial effects on sleep, both in clinical and non-clinical samples. In two studies, the effects were maintained 4 or 6 months post-treatment. The quality of the sleep outcome measures were, however, low in most studies, particularly regarding the participants' nightly sleep habits, self-reported sleep problems and insomnia diagnosis.

Conclusions: Flotation-REST may be a promising treatment for insomnia symptoms, but more controlled studies with established sleep measures, and on populations with clinically verified insomnia, are needed.

1. Introduction

Sleep problems are common in the general population at both subclinical and clinical levels [1]. The most frequent sleep disorder, insomnia, is characterized by difficulties initiating or falling back to sleep, resulting in daytime impairment. It is a risk factor for physical and mental ill-health [1–3], with considerable financial as well as emotional costs to society [4,5].

Evidence-based treatments for insomnia include sleep medications, although these cause unwanted side-effects and risk addiction [6], and behavioural therapy. Although behavioural therapy for insomnia (CBT-I) [7] is recognized as effective, with substantial and enduring improvements in sleep, access to it is low in many parts of the world.

Complementary and Alternative Medicine (CAM) treatments, such as herbs, supplements, meditation, and acupuncture, are frequently used among sufferers from insomnia [8,9], as well as by individuals suffering from psychiatric conditions associated with it, such as depression [10–12]. Although there has been a surge in the study of CAMs for insomnia during recent decades, showing some such as yoga and tai-chi to be promising, there is little knowledge of the effects of flotation-REST [13].

Flotation-REST uses a dark and quiet flotation tank, filled with water saturated with salts (magnesium sulphate and Epsom salts), which enables the patient to float comfortably on his or her back. Maintaining the water at skin-temperature reduces sensory input from the somato-sensory system, and ear-plugs are used to minimize auditory

Abbreviations: AK, Anette Kjellgren (author name); ANC, Annika Norell-Clarke (author name); CBT-I, Cognitive Behavioural Therapy for insomnia; CAM, Complementary and Alternative Medicine; KJ, Kristoffer Jonsson (author name); M, Mean; MT, Maria Tillfors (author name); N, Number; RCT, Randomized Controlled Trial; REST, Restricted Environmental Stimulation Technique; SD, Standard Deviation; VAS, Visual Analogue Scale

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input. Although research on therapeutic applications of sensory deprivation has a long history, including a wide variety of methods and treatment designs [14,15], contemporary research has, with few exceptions, used a developed treatment program consisting of 12 flotation sessions of 45 min over seven weeks [16]. Despite the absence of a scientific knowledge base, an investigation of marketing by private flotation-REST centers found advertisements stating that the method improved sleep for people in general, as well as alleviating insomnia and related issues [17].

At face value, any technique that promotes relaxation may sound plausible for improving sleep, as sleep problems have been consistently associated with stress, worry and arousal [18,19]. In addition, positive effects have been demonstrated on psychological problems and health symptoms that often co-exist with insomnia disorder, such as depression, anxiety and sleepiness [20–22]. As insomnia is often comorbid [23], flotation-REST may be of interest in psychiatry as a treatment for more than one problem simultaneously.

Taken together, a review of flotation-REST is warranted, with a focus on the effects on sleep in healthy individuals, individuals with moderate sleep issues, and sufferers with insomnia disorder. The current systematic review study aim to provide this.

2. Methods

2.1. Selection procedure and inclusion criteria

A systematic search was conducted by KJ and MT during the late autumn 2017 in the databases PubMed, Google Scholar, Web of Science and PsychINFO. An updated/complementary search was conducted by AK in December 2019. The search terms were: flotation (or floating)-REST; Restricted Environmental Stimulation Technique or Restricted Environmental Stimulation Therapy, flotation tank therapy, sensory isolation tank, or sensory deprivation tank in combination with sleep and insomnia. Only studies published in peer-reviewed journals were considered eligible. Due to the small number of published flotation-REST studies that included sleep as an outcome variable, theses and book-chapters were also considered.

The selection process for the current review involved the following steps (see Fig. 1). First, titles and abstracts from the search in the databases were briefly screened by KJ and MT; first independently and then jointly until consensus about inclusion or exclusion was reached. Some articles were found through AK and ANC. In addition, a request for unpublished studies was made on Research Gate by ANC during summer 2017, but without response. Subsequently, KJ and MT screened for duplicates among the identified references. Relevant full-text articles were read by MT and ANC, and the reference-lists of these articles were screened to identify additional studies. Studies were included if they met the following criteria: 1) if they had included a measurement of sleep; 2) if they had a group design (either a within-group design or a randomized controlled trial, RCT); 3) if the participants were over 18 years; and 4) if the articles were written in English. After this screening, nine studies were included: seven peer-reviewed articles, one book chapter, and one doctoral thesis.

2.2. Quality assessment

The methodological quality ratings were based on a modification of the 11 criteria used by Jadad, [24]. In addition to eight of these criteria, one was adopted from Cochrane [25], one concerned the components of the intervention, and one was specifically related to sleep. This combination of criteria has been used in other sleep-related systematic reviews (for example [26]). The assessments were made by MT and ANC, who had not been involved in any of the included studies. A standard extraction sheet was used to summarize each of the individual study ratings (0–22) with higher points indicating higher quality. The 11 parameters were: 1) randomization procedure clearly described, 2)

group allocation concealed for researchers during the intervention, 3) clear description of non-responders, withdrawals, and dropouts, 4) study objectives clearly defined, 5) outcome measures clearly defined, 6) inclusion and exclusion criteria clearly described, 7) sample size justified (e.g., power calculation), 8) statistical methods clearly described, 9) study report free of suggestion of selective outcome reporting, 10) intervention components clearly described (e.g., treatment content and dosage), and 11) a study population with verified sleep problems (e.g., diagnostic criteria for insomnia). Each parameter was rated from 0 (No), 1 (partly/unclear) to 2 (Yes).

3. Results

3.1. Quality assessment

The qualitative methodological assessment was done as follows regarding the included nine studies [16,20,27–33]. MT and ANC independently reviewed and graded all eight studies and then compared ratings. Of the 99 ratings (11 criteria applied to nine studies), 66 were identical, and the discrepancies, which never exceeded a single point, were quickly resolved by discussion.

The study qualitative ratings are presented in Table 1. The mean total quality rating of the studies was 9.6 (range: 6–16; SD: 3.21). The most common limitations among the studies were that group allocation was not concealed to the researchers during the intervention (eight out of nine studies were graded with the lowest score of 0); that sample sizes were not justified (seven out of nine studies were graded 0); and that the study population did not have verified sleep problems (seven out of nine studies were graded 0). Seven of the nine studies were assigned less than half of the possible total score.

3.2. Study characteristics

The number of recruited participants in the studies ranged from six to 80 (with an average of 48). The total number in the eight studies was (see Table 2) was 400 ($M = 44.4$, Range: 6–80), and most were women. Only one of the studies [27] had evaluation of the effects of flotation-REST on insomnia as its primary aim. All participants in this study were diagnosed with insomnia. All other studies except one [32] consisted of clinical samples in which sleep problems are common or healthy athletes [29].

Flotation-REST sessions were of 45 min duration in all cases. Four of the eight studies consisted of twelve such sessions [16,20,28,32], and the other studies varied between one and 33 sessions. Noteworthy, the only one devoted to people with insomnia consisted of the second smallest number of sessions: only four [27].

Flotation-REST was evaluated both alone and in combination with other interventions such as autogenic relaxation, biofeedback and conversational therapy. Six of the nine studies were randomized controlled trials [16,20,27,28,31]. Two of these used an active control group [28,29] and in the others the control group consisted of no treatment (i.e., a passive control). The sleep measurements that were reported consisted of one measure per study, and in all studies but one, these outcomes were self-reported. This exception [27] was the only study in which both subjective and objective sleep measures were included. Lastly, only three of the nine studies included follow-ups [20,27,28].

3.3. Treatments effects

In general, flotation-REST had an effect on sleep in both clinical and non-clinical samples (see Table 2). Further, two studies [20,28] showed that the effect on sleep continued after treatment had finished, for four and six months respectively (although no additional improvement was shown). Another study measured long-term effects [27] and demonstrated that although there was no benefit immediately after treatment,

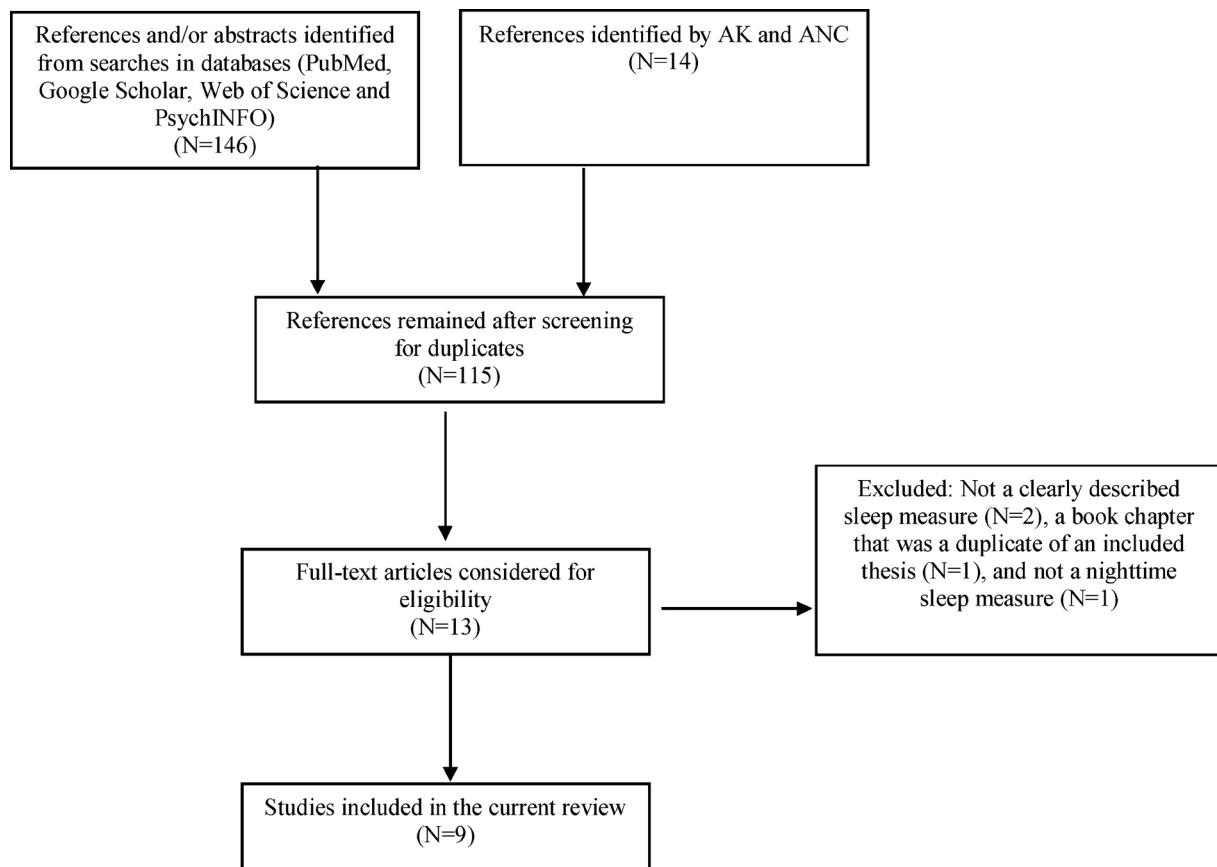


Fig. 1. Flow chart of the selection process.

beneficial effects on sleep were achieved after twelve weeks, on measures both subjective (sleep onset latency and total sleep time) and objective sleep measures (sleep onset latency). This effect appeared to be independent of the number of sessions. However, it should be noted that one study [27] contained only four sessions over a two-week period and that the effect was delayed until twelve weeks follow-up. Further, one RCT [16] examined whether a flotation-REST treatment consisted of 33 sessions was more effective than twelve sessions. Bood and co-workers [16] found that people reported an increase in sleep quality after both twelve and 33 sessions, although 33 sessions did not result in greater improvements than twelve. Regarding threats to internal validity, four studies compared flotation-REST with a passive control group [20,27,31,32], and two studies used active control groups [28]. In all these RCTs, the treatment groups reported improved sleep but not the control groups. Hence, in general, the results indicate that flotation-REST has an effect on sleep, as measured in the studies.

4. Discussion

In general, the results from the review indicate that flotation-REST has a beneficial effect on sleep that continued over time. However, the following weaknesses in the included studies' designs need to be kept in mind when interpreting the results.

Firstly, only one of the studies [27] was specifically designed to investigate sleep problems (insomnia) or used variables related to sleep as a primary outcome. In seven of the eight other studies, sleep problems were one of many outcomes of interest and not clinically verified. This may explain why these studies used general rather than specific measurements ("sleep quality" rather than sleep diaries), and why they devoted little space to describing sleep measurements and sleep-related results. Secondly, most of their participants had various diagnoses, with sleep problems being only one aspect of their ill-health, along with

pain, anxiety or burn-out depression. Lastly, only one study [32] included volunteers from the general public rather than from a clinical setting or sport context, but its findings were in line with those of the others, with a significant increase in sleep quality being reported.

Taken together, whether from clinical or non-clinical samples, the results indicate that flotation-REST does benefit people with subclinical sleep problems, mainly in terms of self-reported sleep quality. Further studies are warranted to investigate whether flotation-REST is effective for sleep problems at clinical levels and on measures that are considered golden standard within the sleep and insomnia treatment field such as structured clinical interviews, sleep logs and psychometrically sound questionnaires [34].

4.1. How would flotation contribute to better sleep? Suggested mechanisms

It is established that floating is an effective aid to deep relaxation and stress reduction, effects that have been confirmed by decreased stress hormones [31]. One explanation for the effects of flotation on sleep may simply be that people become more relaxed. Beneficial effects on sleep from muscle relaxation and musically induced relaxation have been confirmed in the insomnia literature [35,36].

Another explanation is that flotation may increase the ability to regulate and cope with negative emotions. People with insomnia often experience distress and use dysfunctional emotion regulation strategies such as worry and rumination, which have been associated with acute as well as long-term sleep problems [37]. One study applying flotation-REST as a treatment for generalized anxiety found that it decreased dysfunctional emotional regulation [20], so pointing to a beneficial effect that might contribute to improved sleep. Interviews with the participants from the same project [38] suggested that flotation-REST could improve mental health, with benefits to sleep, by promoting positive life-style changes such as seeking out seclusion (turning off

Table 1
Study quality ratings.

Author	Randomization description	Conceal allocation	Withdrawals	Study objectives	Outcome measures	Inclusion/Exclusion	Sample size	Statistical methods	Reporting	Intervention	Verified sleep problems	Total	Percent
Ballard, 1989 [27]	1	0	1	2	2	1	0	1	2	2	1	13/22	59.1
Bood, Sundequist, Kjellgren, Nordström, & Norlander, 2007 [16]	1	0	1	1	1	1	0	1	2	2	0	10/22	45.4
Broderick, Uiga, & Driller, 2019 [29]	1	0	0	1	1	0	0	1	1	2	0	7/22	31.8
Bood, Sundequist, Kjellgren, Norlander, Nordström, Nordenström, & Nordström, 2006 [28]	1	0	1	1	1	1	0	1	2	2	0	10/22	45.4
Jonsson & Kjellgren, 2016 [20]	2	1	2	1	2	1	1	1	2	2	1	16/22	72.7
Kjellgren, Buhrikall, & Norlander, 2011 [30]	0	0	0	1	1	1	0	1	2	1	0	7/22	31.8
Kjellgren, Sundequist, Norlander, & Archer, 2001 [31]	1	0	1	1	1	1	0	1	1	2	0	9/22	40.9
Kjellgren & Westman, 2014 [32]	1	0	0	1	1	0	0	1	2	2	0	8/22	36.4
Koula, Kemp, Keane, & Belden, 1990 [33]	0	0	0	1	0	0	1	1	2	1	0	6/22	27.3
Average	0.89	0.11	0.67	1.11	1.11	0.67	0.22	1.00	1.78	1.78	0.22	9.60	44.9
SD	0.60	0.33	0.71	0.33	0.60	0.50	0.44	0.00	0.44	0.44	0.44	3.21	14.85

mobile phones, being unreachable, walking in nature) and striving to be more relaxed and mindful (by, for instance, taking one day at time).

A third suggested explanation for the effect of flotation on sleep is the induction of mildly altered states of consciousness. Such states potentially combine the benefits of relaxation and reduced stress with those of better emotional regulation. Such altered states during flotation are reminiscent of daydreaming or the hypnagogic or “falling asleep state”, with their particularly vivid mental imagery. Such vivid imagery is associated with increased emotional processing [39], and if it is also evoked by flotation-REST, this may be an important component of the treatment’s beneficial effects on mental ill-health.

4.2. Limitations and strengths

Some limitations of the current review should be noted. First, the qualitative ratings of the nine studies were remarkably low, so the conclusion that flotation-REST is effective for sleep problems is tentative, awaiting new studies with stronger methodology. On the topic of methods, it is regrettable that the designs of the included studies did not allow for a meta-analysis to be conducted. Second, although all studies showed a beneficial effect on sleep, only one of them specified the kind of sleep problems the participants suffered from. Further research is therefore needed to determine whether flotation-REST is effective in clinical sleep problems. Third, in all except one of the studies, the sleep measurements consisted of self-reporting only. However, it is not standard to use objective sleep measurements when diagnosing insomnia and insomnia symptoms [34]. Fourth, the majority of the studies had not calculated power, meaning there is a risk of type-II errors. Despite this shortcoming, all studies found beneficial effects of sleep. Lastly, several of them used self-referred samples, which reduces the external validity.

Despite these limitations, this review has several strengths. First, six of the nine studies were RCTs, which increase the internal validity and reliability of the conclusions. Second, our quality assessment employed established criteria. Third, our literature searches covered several large databases, combined with complementary searches by researchers who knowledgeable about flotation (AK and KJ), making it unlikely that relevant studies have been overlooked.

4.3. Future research and potential implications

Foremost, flotation-REST needs to be evaluated as an insomnia treatment, with sounder measures, and compared with existing treatments (CBT-I) as well as to an active controlgroup. Further, more research is needed to establish to what degree sleep is improved and for whom. In addition, an evaluation of flotation-REST as a transdiagnostic treatment of comorbid problems including insomnia or sleep issues is warranted as flotation-REST has received scientific support as a treatment of stress-related ailments, as well as for pain, mood and anxiety disorders [22]. Development of treatments that can work in a transdiagnostic manner within both primary care and psychiatry is important in the light of the high degree of existing comorbidities, not the least in regard to insomnia, depression, and anxiety disorders. One possible implication is to use floating as a supplement to other existing therapies. In relation to the latter, we want to point out that flotation tank therapy does not require any practice or systematic training. The instructions are simply to enter the tank and lay down; no activity needs to be done, and no special beliefs need to be held. This should not be understated as it people in the greatest need of relaxation training are also those who have most difficulties in implementing and completing such training [40]. Other comparable methods, such as meditation, yoga or qigong often require regular practice and a dedicated focus before benefits become apparent.

Table 2
Description of the included studies (either randomized controlled trials or within group designs) examining flotation-REST on sleep: Design, sample description, treatment type, treatment delivery, outcomes, and findings.

Author	Design	Sample: Size, diagnosis, age (M), % female, % attrition	Treatment type	Treatment delivery	Outcomes	Findings
Ballard, 1989 [27]	RCT	36, insomnia, 33 y, 56%, NR	(a) Flotation-REST only (b) Flotation-REST with autogenic relaxation (c) Autogenic relaxation only (d) Delayed treatment control	(a) 4 flotation sessions à 45 minutes during a 2-week period (b) 4 flotation sessions à 45 minutes each followed by a 30-min prerecorded guided relaxation during a 2-week period (c) 4 sessions à 45 minutes which contained a 30-min prerecorded guided relaxation on a bed in the REST-chamber during a 2-week period	Self-reported SOL and self-reported total sleep time. Objective SOL and total sleep time both measured with Somtrak sleep assessment device (SAD machine),	Flotation-REST alone and in combination with relaxation as well as relaxation alone reduced both self-reported SOL and objective SOL equally well after 12 weeks follow-up. Regarding self-reported total sleep time but not objective total sleep time, the results indicated that all three active treatments increased the total sleep time after 12 weeks follow-up. Nevertheless, the relaxation condition was more effective in increasing the self-reported total sleep time in comparison with the first (a) and second (b) condition, who in their turn did not differ from each other. There were no short time effect (1 and 4 weeks follow-up) found for the three active treatment groups on any of the sleep-measures.
Bood, Sundequist, Kjellgren, Nordström, & Norlander, 2007 [16]	RCT	37, stress-related pain, 50 y, 78%, NR	(a) Flotation-REST, 12 sessions à 45 min (b) Flotation-REST, 33 sessions à 45 min	(a) 2 three-week periods (2 visits per week) (b) 2 three-week periods (2 visits per week) and after that 7 additional three-week periods (one visit per week)	Sleep quality (VAS: 0–100)	Both flotation-REST conditions (12 or 33 sessions) reported a near significant ($p = 0.053$) higher sleep quality after flotation-REST. No follow-up
Bood, Sundequist, Kjellgren, Norlander, Nordström, & Nordström, 2006 [28]	RCT	70, stress-related pain (26 of these participants had also the diagnosis of burnout depression), 49 y, 77%, 0% at post-test and 20% at 4-month follow-up	(a) Flotation-REST, 12 sessions à 45 min (b) Active control group	(a) 2 three-week periods (2 visits per week) (b) Instead of floating the participants "sat in an armchair for 45 minutes and were allowed to read magazines that were laid out for them" (Bood et al., 2006, p 158)	Sleep quality (VAS: 0–100)	For the flotation -REST group: Sleep quality was enhanced, and was maintained 4 months after treatment.
Broderick, Uiga, & Driller, 2019 [29]	RCT	19, athletes, 21 y, 0%, NR	(a) Flotation-REST (b) Active control group	(a) 1 session à 45 min (b) The participants "sat in a temperature-controlled (21 ± 1 °C), dim-lit room for one-hour where they were to refrain from the use of any electronic devices" (Broderick et al., 2019, p 3)	Sleep quality (VAS: 1–10) Objective sleep latency, total sleep time, sleep efficiency, wake after sleep onset, awakenings per hour, and mean wake durations measured via actigraphy.	For the flotation-REST group: Sleep quality was enhanced and the mean wake duration showed a near significant ($p = 0.06$) decrease. No follow-up.
Jonsson & Kjellgren, 2016 [20]	RCT	50, generalized anxiety disorder (defined by self-report measures), 43 y, 70%, 8%	(a) Flotation-REST (b) Passive control group	(a) 12 sessions à 45 min during a 7-week period.	The Pittsburgh Sleep Quality Index (PSQI). Consists of 19 items measuring sleep disturbance.	The participants in the flotation-REST condition reported a larger decrease on sleep disturbance at post-treatment than the control group. 43% in the treatment group and 27% in the control group were considered "good sleepers" at post-treatment. At the six-month follow-up there was no significant difference on sleep disturbance compared to post-treatment for the treatment group ($n = 19$). The sleep quality showed a tendency to a significant increase ($p = .068$) at post-treatment. No follow-up.
Kjellgren, Buhrkall, & Norlander, 2011 [30]	Within-group pre-post design	6, burnout syndrome, 43 y, 67%, NR	(a) Flotation-REST and conversational therapy with a psychologist	(a) 20 sessions flotation-REST à 45 min twice weekly during 10 weeks and 10 sessions conversational therapy à 60 min, individually format once a week immediately after every other floating session.	Sleep Quality (SQ). Consists of 11 items targeting sleeping habits.	
	RCT	37, chronic pain, 32 y, 62%, NR				

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Table 2 (continued)

Author	Design	Sample: Size, diagnosis, age (M), % female, % attrition	Treatment type	Treatment delivery	Outcomes	Findings
Kjellgren, Sundequist, Norlander, & Archer, 2001 [31]			(a) Flotation-REST (b) Passive control group	(a) 9 sessions à 45 min, three times per week	SOL (min), numbers of hours of sleep per night, sleep quality (VAS: 0-100)	The participants in the flotation-REST condition reported a larger reduction on SOL at post-treatment than the control group. No difference was found neither regarding numbers of hours of sleep per night nor regarding sleep quality. No follow-up.
Kjellgren & Westman, 2014 [32]	RCT	65, healthy participants who were part of a cooperative health project, 48 y, 78%, NR	(a) Flotation-REST (b) Passive control group	(a) 12 sessions à 45 min during a 7-week period.	Sleep Quality (SQ). Consists of 11 items targeting sleeping habits.	The participants in the flotation-REST condition reported a larger increase on sleep quality at post-treatment than the control group. No follow-up. Also a negative correlation between sleep quality and perceived stress was found. There was an increase in sleep hours at post-treatment. No follow-up.
Koula, Kemp, Keane, & Belden, 1990 [33]	Within-group pre-post design	80, out-patients where the two most common problems consisted of pain (n = 38) and generalized anxiety (n = 23), NR, NR, 48%	(a) A medically supervised treatment program for stress-disorder consisted of biofeedback and flotation-REST	(a) Mean number sessions given were 11.1 (biofeedback: 3.7 sessions; flotation-REST: 7.4 sessions)	Sleep hours	

Note. flotation-REST = flotation-Restricted Environmental Stimulation Technique, RCT = Randomized Controlled Trial, NR = Not Reported, SOL = Sleep Onset Latency, VAS = Visual Analogue Scale.

5. Conclusions

Flotation-REST may be a promising treatment for insomnia. However, more controlled studies are needed, concentrating upon people with clinically verified sleep problems such as insomnia disorder and using methodologically sounder sleep measures. Accordingly, our group is currently evaluating the results of a small clinical trial (single-case experimental design) of six participants diagnosed with insomnia.

Author note

This work was performed at the Department of Social and Psychological Studies, Karlstad University, Sweden. All authors have seen and approved the final version of the manuscript. This manuscript does not report on a clinical trial.

Declaration of Competing Interest

None.

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