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Internet-vs. group-delivered cognitive behavior therapy for insomnia: A randomized controlled non-inferiority trial

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ABSTRACT

The aim of this study was to compare guided Internet-delivered to group-delivered cognitive behavioral therapy (CBT) for insomnia. We conducted an 8-week randomized controlled non-inferiority trial with 6-months follow-up. Participants were forty-eight adults with insomnia, recruited via media. Interventions were guided Internet-delivered CBT (ICBT) and group-delivered CBT (GCBT) for insomnia. Primary outcome measure was the Insomnia Severity Index (ISI), secondary outcome measures were sleep diary data, depressive symptoms, response- and remission rates. Both treatment groups showed significant improvements and large effect sizes for ISI (Within Cohen's *d*: ICBT post = 1.8, 6-months follow-up = 2.1; GCBT post = 2.1, 6-months follow-up = 2.2). Confidence interval of the difference between groups post-treatment and at FU6 indicated non-inferiority of ICBT compared to GCBT. At post-treatment, two thirds of patients in both groups were considered responders (ISI-reduction > 7p). Using diagnostic criteria, 63% (ICBT) and 75% (GCBT) were in remission. Sleep diary data showed moderate to large effect sizes. We conclude that both guided Internet-CBT and group-CBT in this study were efficacious with regard to insomnia severity, sleep parameters and depressive symptoms. The results are in line with previous research, and strengthen the evidence for guided Internet-CBT for insomnia.

Trial registration: The study protocol was approved by, and registered with, the regional ethics review board in Linköping, Sweden, registration number 2010/385-31.

1. Introduction

Insomnia is a disorder of difficulty initiating and/or maintaining sleep, with impaired daytime functioning as a consequence. It is a common disorder with around 10–30% point prevalence reported in various studies (Kim, Uchiyama, Okawa, Liu, & Ogihara, 2000; Mellinger, Balter, & Uhlenhuth, 1985; Ohayon & Roth, 2003). Insomnia causes serious suffering and is a substantial economic burden to society due to sick leave and utilization of health care resources (Daley, Morin, LeBlanc, Gregoire, & Savard, 2009; Sivertsen, Overland, Bjorvatn, Maeland, & Mykletun, 2009; Walsh, 2004). There is also increasing evidence that disturbed sleep is a predictor for many other health problems, of which depression, anxiety and substance abuse are among the most studied (Baglioni et al., 2011; Breslau, Roth, Rosenthal, & Andreski, 1996; Ohayon & Roth, 2003; Taylor et al., 2007). Evidence based treatment for insomnia consists of pharmacotherapy and/or psychotherapy. Pharmacotherapy has moderate to large effects but is mainly intended for short term use (Nowell et al., 1997), and symptoms often recur after treatment (Riemann & Perlis, 2009). Cognitive behavioral therapy (CBT) has been found effective both in the short and long term (Okajima, Komada, & Inoue, 2014). Two reviews of sleep medication and psychotherapies have concluded that sleep medication and CBT are equally effective short term, but that CBT is more effective in the long term (Mitchell, Gehrman, Perlis, & Umscheid, 2012; Riemann & Perlis, 2009).

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Even though CBT for insomnia is broadly considered treatment of choice, few patients suffering from insomnia receive CBT due to a lack of trained therapists (Edinger, 2009; Espie, 2009; Larsson, Kaldo, & Broberg, 2010). Many studies have been conducted to investigate new ways of disseminating CBT. Group therapy, bibliotherapy, telephone therapy and Internet therapy have all proven effective (Espie et al., 2007; Ho et al., 2015; Jansson & Linton, 2005; Jernelöv et al., 2012; Koffel, Koffel, & Gehrman, 2015; Ström, Pettersson, & Andersson, 2004; van Straten et al., 2013), also for insomnia comorbid with depression (Blom et al., 2015). Internet-delivered CBT (ICBT) is a growing field (Hedman, Ljótsson, & Lindefors, 2012). Therapist guided ICBT has a potential to be more therapist-efficient than both individual and group-CBT (GCBT): less therapist time is normally needed per patient, thus each therapist can treat more patients during a certain time period (Andersson, 2009; Barak, Klein, & Proudfoot, 2009). Another advantage of ICBT is that therapy is not restricted to a specific time or geographical place. This implies that therapy is available also to patients living far away from a clinic, or without the possibility to come during office hours (Andersson, 2014).

To further the evidence for ICBT, it needs to be compared directly to traditional treatment. Previous studies on guided ICBT for other conditions show that guided ICBT has been equivalent to face-to-face treatment (Andersson, Cuijpers, Carlbring, Riper, & Hedman, 2014). Although a recent meta-analysis indicates that self-help CBT for insomnia is as effective as face-to-face treatment with CBT (Ho et al., 2015), to our knowledge, there are no published studies directly comparing ICBT for insomnia to face-to-face treatment.

The aim of this study was to compare guided Internet-delivered CBT to group-CBT in a randomized controlled non-inferiority trial, investigating treatment effects post treatment and after six months. The primary aim was to investigate the effects on insomnia, a secondary aim was to investigate the effects on participants' level of depression and sleep medicine use. Given the aforementioned results from previous research, the hypothesis was that ICBT is not inferior to GCBT and that achieved results would be sustained over the follow-up period.

2. Method

2.1. Participants and recruitment

This study was open to adults living in the region of Östergötland County, Sweden. The participants were recruited via a national recruitment website (www.studie.nu), a radio program and ads in local newspapers. The study protocol was approved by, and registered with, the regional ethics review board in Linköping, Sweden, registration number 2010/385-31.

Inclusion criteria were:

a) 18 years or older
b) Insomnia diagnosis according to the research criteria from the American Academy of Sleep Medicine (Edinger et al., 2004), with more than 10 points on Insomnia Severity Index, ISI (C.M. Morin, 1993), which is the recommended cutoff to detect insomnia cases (C. M. Morin, Belleville, Belanger, & Ivers, 2011)
c) Ability to participate in group meetings
d) Ability to read and write in Swedish.

Exclusion criteria were:

e) Comorbid sleep disorders urgently requiring other treatment (sleep apnea or narcolepsy)
f) Ongoing alcohol or drug abuse
g) Change in antidepressant medication within the past 2 months
h) Comorbid disorders directly contraindicative of essential interventions in insomnia treatment (e.g., bipolar disorder) or urgently requiring other treatment (e.g. severe depression and suicidal ideation, i.e. having >30 p on the self-report version of the Montgomery Åsberg Depression Rating Scale (MADRS-S) (Montgomery & Asberg, 1979), (Svanborg & Åsberg, 1994) or > 3 p on the suicide ideation item 9 or diagnosed with severe depression or suicidality at assessment)
i) Other on-going psychological treatment
j) Night-shift work

Comorbidities were allowed, apart from what is mentioned in exclusion criteria e, f and h. There was no restriction on sleep medication use.

2.1.1. Initial screening

Participants applied via a secure website, received information about the study and gave their consent. They filled out a number of screening questionnaires including: contact information, background data, specific questions on sleep related disorders, questions on other psychiatric and somatic disorders, ISI, MADRS-S and the Alcohol Use Disorders Identification Test (AUDIT) (Saunders, Aasland, Babor, De La Fuente, & Grant, 1993). AUDIT was input to the assessment of alcohol and drug abuse.

2.1.2. Structured telephone interview

Participants not excluded after the initial screening were interviewed by telephone. The interview encompassed: checking diagnostic criteria (inclusion criteria b) for insomnia using 1, an interview version of ISI, 2, a question on adequate opportunity and circumstance for sleep, and 3, questions on daytime fatigue (Epworth Sleepiness Scale, ESS (Johns, 1991)); checking motivation and ability to take part; a follow up on findings from the initial screening regarding sleep related disorders, other psychiatric and somatic disorders and use of medicines. Patients not excluded at this stage were booked for a live assessment.

2.1.3. Live assessment

The live assessment took 15–50 min and focused on: checking the diagnostic criteria for insomnia; asking about daytime functioning using ESS; assessing depressive symptoms using the depression section of the Structured Clinical Interview for DSM-IV, SCID-I (First, Gibbon, Spitzer, Williams, & Benjamin, 1999). When indicated in the initial screening or telephone interview participants were asked about suicidal ideation, alcohol consumption, medication, bipolar disorder and sleep disorders other than insomnia. All interviews were reviewed in a meeting where the principal investigator, (GA) made the final decision on inclusion based on the interviews and screening data. Participants excluded at this stage were offered to get the Internet version of the treatment outside of the study, or referred to other caregivers when relevant (see Fig. 1).

2.2. Randomization and assessment points

Treatment was provided in two arms, group therapy (GCBT) and therapist guided Internet-delivered therapy (ICBT). Participants, (n = 48) were randomized to treatment conditions (n = 24 per group) by university staff not involved in the study, using a free randomization service online (www.randomizer.org). The group therapy participants were divided into three groups with 8, 9 and 7

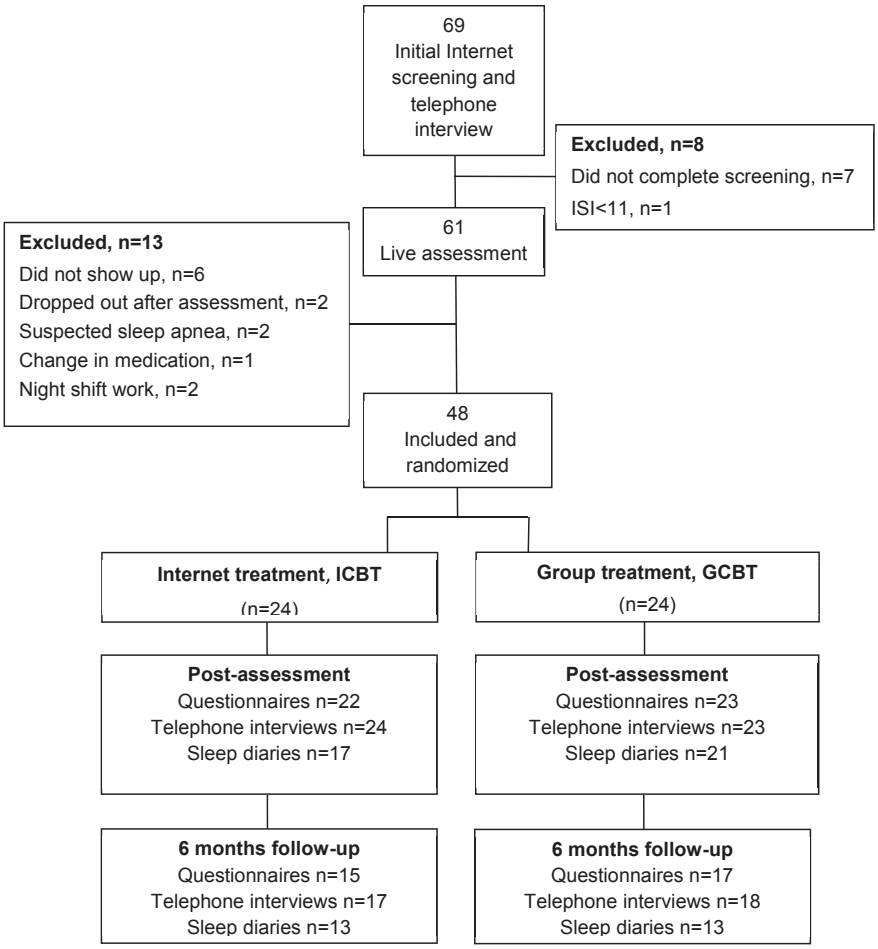

Fig. 1. Participant flow and reasons for exclusion. ICBT = Internet-delivered cognitive behavioral therapy, GCBT = group-delivered cognitive behavioral therapy, ISI = Insomnia Severity Index, Post = after treatment.

participants respectively. Sleep diaries and questionnaires were filled out online by both ICBT and GCBT. Outcome measures were assessed at treatment start (pre-assessment), after treatment (post-assessment), and 6 months after treatment. MADRS-S and ISI were also administered after 4 weeks of treatment in order to monitor progress. If participants had increased depressive symptoms and/or suicidal ideation according to MADRS-S, therapists would telephone the participant to assess suicidal thoughts and plans. Assessment would be made in conjunction with the principal investigator who was responsible for patient safety. If needed, the participant could then be referred to a local caregiver, or meet with a psychiatrist involved in the study. This did, however, not happen.

2.3. Assessor and therapists training and adherence

Telephone interviews, live assessments and therapy were conducted by final-year students (n = 4) of clinical psychology at master level, with theoretical and practical training in CBT, including at least 12 months of providing supervised face-to-face psychotherapy. Assessments were supervised by a licensed clinical psychologist/CBT-therapist involved in the study (principal investigator, GA). A psychiatrist was available for consultations if necessary. Assessors after treatment and at 6 months follow-up were blind to treatment condition. Group treatment supervision was provided by licensed clinical psychologists with expertise in CBT and insomnia treatment, attending group sessions. Internet therapy was supervised weekly, as well as in between sessions when requested, by a licensed clinical psychologist involved in the study (KB), with expertise in ICBT and insomnia treatment. Therapists were introduced to Internet and group delivered CBT for insomnia by the supervising psychologists before treatment start.

2.4. Outcome measures

2.4.1. Primary measures

2.4.1.1. Insomnia severity. Primary outcome measure was self-rated insomnia severity as measured with the ISI. Psychometric properties of the ISI are adequate and it has been found sensitive to change (Bastien, Vallieres, & Morin, 2001), also when administrated online (Thorndike et al., 2011). Participants in both groups completed the self-report measures online via a secure website.

As self-rated data can be difficult to obtain from all participants post-treatment, especially in Internet treatment research with participants mostly off-site, data was also acquired by telephone at all assessment points. This data was used as a basis for imputing missing Internet-rated ISI-data, according to recommendations by Hedman and colleagues (Hedman, Ljótsson, Blom, et al., 2013). To keep the interview brief, ISI was shortened to include only the five diagnosis-related questions (1a-c, 2 and 3). The questions were asked exactly as in the original version and alternative answers were read verbatim. The patients then chose one of the alternatives, so the telephone-data would be as similar to the self-rated

online data as possible. More about this method is explained in the section Statistical Analyses.

2.4.2. Secondary measures

2.4.2.1. Sleep diary. A sleep diary was used throughout treatment. Data from the first and last (eighth) week were used as pre- and post-treatment measurements. Each participant registered bedtime, time of falling asleep, night-time awakenings, time of waking up, and time of getting out of bed. Also, subjective sleep quality was rated daily on a five-point scale from very poor to very good. From these data we calculated sleep efficiency, sleep onset latency, total sleep time, and sleep quality.

2.4.2.2. Remitters and responders. Remission from insomnia was measured at post-treatment and at the 6 months follow-up in two ways: a) in a telephone interview using research criteria (Edinger et al., 2004) to determine if the participant had the diagnosis, and b) using the remission criteria stipulating that ISI score for the participant should be less than 8 points (Morin & Espie, 2003).

Participants were considered responders if the ISI-score decreased with 8 points or more (C. M. Morin et al., 2011).

2.4.2.3. Depressive symptoms. Depressive symptoms were measured with MADRS-S at all assessment points. MADRS-S is a frequently used, validated instrument for measuring and detecting changes in the severity of depression (Montgomery & Asberg, 1979), (Svanborg & Åsberg, 1994).

2.4.2.4. Sleep medication. Sleep medication usage was registered at the live pre-assessment and in telephone interviews at post- and 6 months assessments.

2.5. Adherence, client satisfaction and adverse events

Adherence was measured by checking the number of modules completed (ICBT) and group sessions attended (GCBT). The Client Satisfaction Questionnaire (CSQ-8) (Larsen, Attkisson, Hargreaves, & Nguyen, 1979) was used to assess participants' satisfaction with treatment. More than 7 points increase on ISI, regarded as a clinically significant worsening of symptoms (C. M. Morin et al., 2011), was considered a negative effect. All participants were asked about adverse events in the post-treatment telephone interview with the question “Did the treatment have any negative consequences?” If yes, they were asked to elaborate.

2.6. Interventions

Both treatments were based on the same manual, treatment lasted 8 weeks and group and Internet therapy were conducted in parallel.

2.6.1. Treatment content

The treatment was based on a self-help manual previously published in a book (Jernelöv, 2007), which has been tested in two randomized clinical trials with large effect sizes (Blom et al., 2015; Jernelöv et al., 2012). The book was adapted and shortened into eight modules, which were in turn used as treatment modules in ICBT and as group therapy material (one module per session) in GCBT. The main focus of the treatment was on sleep restriction and stimulus control, which was emphasized throughout the treatment. The other strategies and techniques in the manual were introduced as a sort of “smorgasbord”, where the participants could choose to work with the strategy they found most appealing. See Table 1. Participants were instructed to fill out a sleep diary online every week of the treatment.

2.6.2. Group therapy

Group sessions were held during office hours and lasted 120 min including a short break with refreshments (coffee/tea). A designated therapist and one supervising co-therapist attended each session. The therapists used the same presentations and handout material. Sessions included going over the participants' sleep diaries, the homework assignments of the past week, the contents of the new treatment module and its exercises, and the new homework assignment. There was also time for discussions, reflections about the treatment and questions. The text material handed out in each session was identical to the text in the corresponding Internet treatment module for the same week. The individual sleep diaries, filled out online, were printed by the therapist before each session and handed out with written comments about, for example, sleep times and sleep hygiene. If patients did not show up to group, they were contacted by the therapist by telephone.

2.6.3. Therapist guided internet-delivered therapy

The Internet-delivered CBT included active support by trained therapists, and was built up by the same eight modules as in GCBT, only adapted to and accessed on a secure website. A module consisted of text to read, questions to answer on theory, behavioral assignments (e.g. sleep restriction), work sheets and a sleep diary. The participants were recommended to complete one module per week. Each module ended with the participant sending in a homework report via the secure messaging system. The therapist received the message, and within 24 h on weekdays they reviewed the homework assignments, gave written feedback and then gave the participant access to the next module. The participants could send questions to their therapist, which were answered within 24 h on weekdays. If the participant was inactive for 7 days, the therapist would send a mobile phone text message encouraging the participant to get in touch and continue treatment. If there was no response, the therapist would try to reach the patient by telephone.

2.7. Statistical Analyses

2.7.1. Baseline data and imputation method

t-test, χ^2 associations and Fisher Exact Test were used to compare baseline data. When data was missing for the self-rated primary outcome measures, they were replaced with self-rated data acquired by the telephone interview, when available. A linear regression formula was used to impute missing Internet values (ISI) from telephone values (ISI-items 1a-c, 2, and 3). The regression formula was calculated using post- and follow-up data from 168 participants in two previous insomnia studies where the telephone measure (independent variable) and the Internet measure (dependent variable) were scored within 1 w. These measures were highly correlated ($r = 0.83$, $p < 0.0001$). The interview version of ISI had a Cronbach α of 0.83. Secondary outcome measures, except Sleep diary, were analyzed using available data.

2.7.2. Mixed-effect model

We used linear mixed-effects modeling to evaluate outcome changes for primary outcome data (insomnia severity), as well as for the secondary outcome data depressive symptoms and sleep diary data. Using maximum likelihood estimation, linear-mixed effect models incorporate all available data to estimate parameters in the model, making it a full intent-to-treat analysis. Linear mixed modeling is a frequently recommended method for superiority as well as non-inferiority trials for its abilities to handle missing data and correlated observations in repeated-measures data (Gueorguieva & Krystal, 2004; Yoo, 2010). The best-fitted model to the data consisted of a linear and quadratic function of

Table 1
Content of the treatment modules/sessions.

No	Module/session overview	Content and exercises
1	Facts about sleep and insomnia	Sleep cycles, why we sleep, consequences of sleep loss, insomnia diagnosis, myths about sleep. Fill out sleep diary.
2	Introduction to CBT for insomnia, a model of sleep, sleep hygiene, sleep medication	Model for the connection between situation-behavior-cognitions-emotions, triggers for insomnia, sustaining factors, inner (caffeine, alcohol, food, nicotine, exercise) and outer (cool and dark room, silence) sleep hygiene, information about sleep medication and how to discontinue – cold turkey or tapering. Fill out sleep diary.
3	Sleep restriction and stimulus control	Rational and instructions on how to do it, information about the effects of napping, how to handle fatigue (including relaxation techniques). Fill out sleep diary.
4	Planning of sleep restriction and stimulus control, examining your motivation for change, day time activity and going-to-bed-routines	Setting sleep schedule for coming week, examining short- and long term consequences of completing treatment or not, importance of daylight and daytime activity, exercise, relaxation techniques for sleep, visualization. Fill out sleep diary.
5	Continuation of sleep restriction and stimulus control, acceptance training, more visualization and focus training/mindfulness	Setting sleep schedule for coming week, handling sleep disturbing worry and rumination through visualization and mindfulness exercises. Fill out sleep diary.
6	Continuation of sleep restriction and stimulus control, cognitive reappraisal	Setting sleep schedule for coming week, registration of negative thoughts about sleep, thinking traps, defusion strategies, behavioral experiments challenging negative cognitions about sleep. Fill out sleep diary.
7	Continuation of sleep restriction and stimulus control, continued work with previously introduced strategies, techniques for acceptance, handling worry about sleep	Setting sleep schedule for coming week, scheduled worry, problem solving, challenging ideas about the perfect sleep and life. Fill out sleep diary.
8	Continuation of sleep restriction and stimulus control, relapse prevention and planning ahead	Setting sleep schedule for coming week, summarizing the treatment, making a plan for sleep times and other strategies for the near future, how to handle relapse. Fill out sleep diary.

time, fixed effects of condition, condition by time interactions, and correlated error terms. Statistical analyses were performed using SPSS version 22 (IBM Inc., Armonk, NY, USA).

2.7.3. Non-inferiority margin and analysis

A critical part of doing a non-inferiority study is determining the non-inferiority margin, or delta (Piaggio et al., 2006). To determine whether the ICBT was inferior to GCBT the confidence interval approach was used (Piaggio et al., 2006; Yoo, 2010). If the lower-limit of the two-sided 95% confidence interval of mean difference between conditions is less than the pre-specified non-inferiority margin, non-inferiority is established.

We could only locate one report of a non-inferiority trial on insomnia, using ISI as the primary outcome (Garland et al., 2014). Thus, there is no established recommended delta. Yang and colleagues (Yang, Morin, Schaefer, & Wallenstein, 2009) used data from a large randomized controlled trial ($n = 828$) on the efficacy of eszopiclone for insomnia, to established a minimally important difference (MID) in ISI score before and after treatment. They compared ISI scores to a selection of items representing a change in health, daytime functioning and quality of life. In the study from Yang and colleagues, a score reduction of more than 4 points on ISI was found representing a significant predictor of decreased risk of a negative treatment outcome, and was associated with an increase in vitality and a decrease in fatigue. A score reduction of 6 points was related to even more positive outcomes than 4, and was chosen by the authors as the recommended MID for efficacy studies, since a more conservative MID reduces the risk of an overestimation of treatment effects.

As a conservative estimate of MID for the purpose of this non-inferiority trial, where a smaller margin is more conservative, we chose a non-inferiority margin of 4 points on ISI for the analysis. This means, that the mean difference between the groups should not be more than 4 points in favor of GCBT, to establish non-inferiority of ICBT. The chosen margin, 4 points, was also used by Garland and colleagues in their non-inferiority study (Garland et al., 2014), but with a slightly different motivation. We retrieved the estimates (along with standard errors and confidence intervals) of the mean difference between groups at post-treatment and at the 6 months follow-up from the mixed model analysis.

In accordance with recommendations for non-inferiority trials (Piaggio et al., 2006; Yoo, 2010), we also performed a sensitivity analysis of the primary outcome ISI for a per-protocol sample. Participants were considered as per-protocol if they completed more than five of the eight modules/sessions of the treatment. It was deemed that this would correspond to a sufficient dose of the treatment, since the main treatment components had then been introduced and exercises had commenced.

2.7.4. Power analysis

A power analysis was made according to the method recommended by Tamayo-Sarver with colleagues (Tamayo-Sarver, Albert, Tamayo-Sarver, & Cydulka, 2005). In the analysis we used 4 point as the non-inferiority margin (δ^*), 8 points as the clinically significant difference (δ) (C. M. Morin et al., 2011), 25 for variance ($s = 5$), group size (n) is 24 (total $N = 48$) and α was set to 2.5% since our non-inferiority analysis was calculated with a two-sided 95% confidence interval. This calculation resulted in a power of 0.79 for the primary outcome analysis.

2.7.5. Effect sizes, remission, responders and sleep medication

Within group effect sizes were calculated with observed data using Cohen's *d* for repeated measures (Dunlap, Cortina, Vaslow, & Burke, 1996). We used χ^2 associations and the Fischer Exact Test to test for differences between groups regarding responders, remission from diagnosis and use of sleep medicine pre-treatment to post-treatment and 6 months follow-up.

3. Results

3.1. Baseline characteristics

The two groups showed no significant differences on any of the outcome measures before treatment and there were no differences regarding baseline demographics, except for educational level which was higher in the ICBT group ($p = 0.03$). See Table 2.

Table 2
Patient characteristics at baseline.

Variable	GCBT (n = 24)	ICBT (n = 24)
Mean age y (SD)	52.6 (16.6)	56.1 (10.2)
Sex, n (%)		
Female	15 (62.5%)	8 (33%)
Male	6 (25%)	14 (58%)
Education n (%)		
Primary school	7 (29%)	3 (13%)
High school	9 (38%)	5 (21%)
University	8 (33%)	16 (67%)
Occupational status n (%)		
Working/studying	13 (54%)	15 (63%)
Sick leave	2 (8%)	2 (8%)
Job seeking	1 (4%)	2 (8%)
Retired	8 (33%)	5 (21%)
Sleep medication users n (%)	16 (67%)	14 (58%)
ISI score, mean (SD)	18.2 (4.1)	18.7 (4.4)
MADRS-S score, mean (SD)	14.2 (5.6)	13.5 (8.0)

Note. GCBT = Group receiving cognitive behavior therapy in group format, ICBT = Group receiving Internet-based cognitive behavior therapy, ISI = Insomnia Severity Index, MADRS-S = Montgomery Åsberg Depression Rating Scale – Self rated, SD = standard deviation.

Sensitivity analyses were executed to check for any primary outcome effects of the difference in educational level (see primary outcome section).

3.2. Attrition

At post-treatment assessment, overall missing data for the primary outcome measurement ISI was 2% (1 participant from GCBT). This was after imputation from telephone interviews for 2 participants (both in ICBT). At the 6 months follow-up, data was imputed for 4 participants (1 in GCBT and 3 in ICBT), resulting in 27% missing data overall, evenly distributed between the groups (6 in GCBT and 7 in ICBT).

Sleep diary compliance is presented in Fig. 1. Missing data for the other secondary measurements were as follows: MADRS-S, post-treatment: 3 (GCBT:1, ICBT:2), 6 months follow-up: 17 (GCBT:7, ICBT:10); Remitters and responders using ISI, remission using diagnostic criteria and use of sleep medication, post-treatment: 1 (GCBT), 6 months follow-up: 13 (GCBT:6, ICBT:7).

3.3. Adherence and client satisfaction

No significant difference between groups was found regarding patient satisfaction (CSQ-8), GCBT mean value, M = 27.5 (SD = 5.1), ICBT M = 25.0 (SD = 5.5). No significant difference was found regarding number of group meetings (GCBT) or modules (ICBT) completed, GCBT M = 6.8 (SD = 2.1), ICBT M = 6.1 (SD = 2.8). Patients in ICBT had a weekly therapist time of M = 23 min (SD = 15) whereas the group condition had 120 min per group session.

During treatment, at different time points, 13 participants (7 in ICBT and 4 in GCBT) dropped out, i.e. stopped coming to sessions or stopped being active on the Internet. Eight of these participants (5 from ICBT and 3 from GCBT) still completed post-treatment assessment.

3.4. Primary outcome measures

Within group effect sizes are presented in Table 3. Mixed model analyses showed that both treatment groups improved significantly from pre-to post-assessment, and improvements were sustained at the 6 months follow-up ($p < 0.001$). See Fig. 2. There was no significant interaction effect of group and time ($p > 0.58$). Estimated mean raw difference between the groups was −1.31 (95% CI = −3.99–1.36) at the post-assessment and −0.88 (95% CI = −3.92–2.16) at the 6 months follow-up, both in favor of GCBT. Hence, the lower limit of the 95% CI was within the specified non-inferiority margin of 4 points both at post-treatment and at the 6 months follow-up.

The per-protocol sensitivity analysis encompassed 16 participants in ICBT and 20 in GCBT and was consistent with the intent-to-treat analysis in terms of interaction, group differences and non-inferiority (post: 95% CI = −3.84 to 2.19; 6 months follow-up: 95% CI = −3.62–2.88). Sensitivity testing for the baseline difference in educational level did not affect the model or outcomes regarding significance or non-inferiority.

3.5. Secondary outcome measures

3.5.1. Sleep diary

Both groups improved significantly from pre to 6 months follow-up on sleep efficiency, sleep latency and sleep quality ($p < 0.001$, except sleep quality for ICBT which had $p < 0.05$). GCBT improved significantly on total sleep time ($p < 0.05$) whereas ICBT did not. Within group effect sizes at post-treatment and at 6 months follow-up are presented in Table 3. Analysis with mixed model showed no significant group difference ($p = 0.4–0.8$) nor interaction of group and time ($p = 0.08–0.7$) on any of the sleep diary outcomes.

3.5.2. Remitters and responders

There was no significant difference between the groups regarding remission from diagnosis when assessed via telephone interview, using diagnostics criteria: 75% (18) in GCBT and 63% (15) in ICBT no longer had the diagnosis post-treatment ($\chi^2 = 1.39$, $p = 0.24$), and at the 6 months follow-up 72% in GCBT were in remission (13 out of 18 reached) and 76% (13 out of 17 reached) in ICBT (Fischer Exact Test value = 1, $p = 1.0$).

When using the criteria that ISI should be below 8 points to define patients in remission, the groups did not differ significantly: 50% in both groups (12 out of 23 in GCBT and 12 out of 24 in ICBT) were in remission at post-treatment ($\chi^2 = 0.02$, $p = 0.9$). At the 6 months follow-up, the corresponding numbers were 44% in GCBT (8 out of 18 reached) and 35% in ICBT (6 out of 17 reached), $\chi^2 = 0.3$, $p = 0.6$.

There was no significant difference between the groups regarding number of responders: 67% in GCBT (16 out of 23) and 63% in ICBT (15 out of 24) had a >7 p reduction on ISI post-treatment, and 55% in GCBT (10 out of 18) and 59% in ICBT (10 out of 17) at the 6 months follow-up ($\chi^2 = 0.6$, $p = 0.4$ and $\chi^2 = 0.02$, $p = 0.9$, respectively). Assuming all participants with missing data were non-responders and non-remitters, did not change overall statistical inferences.

3.5.3. Depressive symptoms

Both groups improved significantly regarding depressive symptoms measured with MADRS-S ($p < 0.01$). There was no significant group difference ($p > 0.3$) or interaction between group and time ($p > 0.3$). Effect sizes are presented in Table 3.

3.5.4. Sleep medication use

The number of participants using sleep medicine at each time point is presented in Table 3. There was no significant difference between groups pre to post, nor from pre to 6 months follow-up.

3.6. Negative effects and adverse events

No participants had a reliable change for the worse (>7 p

Table 3
Means, standard deviations and effect sizes (standardized mean difference) for observed data: primary outcome measures, depressive symptoms and sleep diary data. Number of sleep medicine users at each assessment.

Measure (scale range)	Group	Pre M (SD)	Post M (SD)	FU6 M (SD)	Effect size within group (Cohen's *d*)	
					Pre-post (95% CI)	Pre-FU6 (95% CI)
ISI (0–28)	GCBT	17.9 (3.9)	8.4 (4.9)	8.4 (4.9)	2.13 (1.02–3.25)	2.17 (0.87–3.46)
	ICBT	18.7 (4.4)	9.7 (5.3)	9.3 (4.8)	1.81 (1.2–2.41)	2.08 (1.02–3.14)
MADRS-S (0–54)	GCBT	14.1 (5.7)	8.4 (6.9)	9.6 (7.2)	0.89 (0.44–1.35)	0.70 (0.22–1.19)
	ICBT	12.5 (7.5)	7.7 (6.1)	7.7 (6.7)	0.69 (0.3–1.08)	0.83 (0.25–1.4)
Sleep Efficiency	GCBT	67% (14%)	87% (4%)	82% (12%)	1.78 (1.0–2.55)	1.24 (0.69–1.78)
	ICBT	73% (11%)	88% (6%)	83% (6%)	1.51 (0.75–2.27)	0.93 (0.25–1.62)
Sleep Latency h:min	GCBT	0:53 (0:31)	0:22 (0:12)	0:23 (0:22)	1.31 (0.44–2.18)	0.88 (0.19–1.57)
	ICBT	0:55 (0:42)	0:18 (0:07)	0:27 (0:15)	1.1 (0.38–1.82)	0.93 (0.05–1.81)
Total Sleep Time h:min	GCBT	5:47 (1:14)	6:19 (0:50)	6:25 (0:55)	0.48 (0.44–2.18)	0.88 (0.28–1.48)
	ICBT	6:04 (0:53)	6:12 (0:53)	6:35 (0:36)	0.14 (−0.36 to 0.64)	0.59 (0.18–1.01)
Sleep Quality (1–5)	GCBT	2.3. (1.0)	3.5 (0.8)	3.1 (0.9)	1.32 (0.35–2.29)	0.85 (0.14–1.56)
	ICBT	2.7 (0.5)	3.3 (1.9)	2.9 (1.1)	0.72 (0.1–1.34)	0.24 (0.36–0.84)
Sleep medicine users		**Pre (n)**	**Post (n)**	**FU6 (n)**	**Fischer exact test value**[a] **(*p*)**	
	GCBT	16	3	3	0.2 (0.24)	
	ICBT	14	6	6		

Note. GCBT = group receiving cognitive behavior therapy in group, ICBT = group receiving Internet-delivered cognitive behavior therapy, ISI=Insomnia Severity Index, MADRS-S=Montgomery Åsberg Depression Rating Scale – Self rating, M = Mean value, SD = standard deviation, 95% CI = 95% confidence interval, Pre = before treatment, Post = after treatment, FU6 = 6-months follow-up.
[a] Fischer exact test value Pre-post and Pre-FU6.

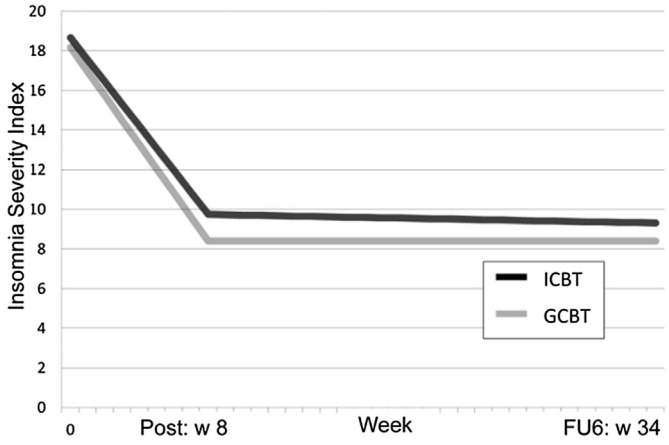

Fig. 2. Outcome on Insomnia Severity Index (observed data) from pre-treatment to 6 months follow-up. ICBT = Internet-delivered cognitive behavioral therapy, GCBT = group-delivered cognitive behavioral therapy, Post = after treatment, FU6 = 6 months follow-up.

increase on ISI) post-treatment or at the 6 months follow-up. Two participants in GCBT had a higher post-than pre-treatment score on ISI (3 and 7 points increase respectively), no participants in ICBT had a higher post-treatment score. One participant in each group had a higher 6 months follow-up- than pre-treatment score (1 (GCBT) and 3 (ICBT) points increase).

The post-assessment question about negative consequences of the treatment was answered affirmatively by 9 participants (19%), 3 in GCBT and 6 in ICBT (non-significant difference, Fischer exact statistic test value = 0.5, P = 0.46). These participants had a 3–11 point decrease in ISI from pre-to post-treatment. Three of the complaints (2 in GCBT and 1 in ICBT) were expected effects of interventions, temporary and considered acceptable by the patients (having to stop driving temporarily; being very sleepy during the beginning of sleep restriction; not being allowed to read in bed). One participant (ICBT) had high hopes for the treatment and was disappointed, one found the treatment stressful and two became more fixated on sleep and had increased worry about sleep, one had increased headache and a minor traffic incident after getting little sleep. One person in GCBT was worried about relapsing into burnout syndrome.

4. Discussion

The main finding in this study was that both treatment groups improved significantly, with large effect sizes for the primary outcome, insomnia severity. The secondary outcome measures (sleep diary data, responders, remitters, sleep medicine use, depressive symptoms) also showed positive results with small to large effect sizes. Using a margin of 4 points on the ISI, the non-inferiority analyses confirmed that there was not a clinically meaningful difference between the two treatment modalities. In addition, there were no statistically significant differences between the groups on any outcome measure at post-treatment or 6 months follow-up assessments. Two thirds of the participants in both groups were regarded as treatment responders at post-treatment, and the number of participants in remission was similar for both groups.

Previous studies have found that insomnia treatment is effective to reduce depressive symptoms, also when participants have a depression diagnosis with moderate severity (Blom et al., 2015; Manber et al., 2008; Okajima et al., 2014). The participants in this study had, on average, mild depressive symptoms pre-treatment. The results corroborate previous findings that insomnia treatment can be effective in reducing depressive symptoms, both when delivered in group format and as therapist guided Internet treatment.

When benchmarking the outcome of the experimental treatment against the results in other studies using ICBT or group therapy, we find that the Internet-delivered treatment in this study fares well. Most of the previous group- or Internet-delivered therapy studies did not use ISI as primary outcome measure, but when comparing sleep diary data at post-assessment, guided ICBT in this study did well compared to other guided and un-guided Internet-treatments (Lancee, van den Bout, van Straten, & Spoormaker, 2012; Ritterband et al., 2009; Ström et al., 2004; van Straten et al., 2013). The effect of guided ICBT in this study is also comparable to group therapies for insomnia in previous research. We find, for example, that the effect size for sleep efficiency in the group-

CBT meta-analysis by Koffel and colleagues (Koffel et al., 2015) was 0.52–1.65 at post-treatment, compared to 1.51 for guided ICBT in this study. Furthermore, when comparing the effect of the group therapy (GCBT) in this study to those in the same meta-analysis (Koffel et al., 2015), it seems this particular group-therapy was more than average effective (e.g. effect size for sleep efficiency = 1.78). Thus, it is unlikely that the non-inferiority of ICBT observed is caused by poor delivery of the group treatment.

The design of this study does not permit drawing conclusions about mechanisms of action, but some aspects are still of interest to discuss. Researchers have highlighted that for ICBT it is most likely important a) to make a thorough diagnosis, b) that the treatment is comprehensive, c) that it is user friendly, and d) that therapist support is provided and there is a deadline for the treatment duration (Andersson, Carlbring, Berger, Almlov, & Cuijpers, 2009). At least criteria a, b and d were fulfilled for ICBT in this study. The group contingency may have had unusually comprehensive text material for the participants, since it was the same as in the Internet contingency. This may have affected outcome for GCBT in a positive way compared to other group treatments. It is possible that there are differences in the mechanisms of action for the different modes of delivery: a supportive group climate might have had a positive effect in GCBT, which may in turn be balanced by the fact that participants in ICBT had the possibility to interact more frequently with the therapist – something that has been found to increase effects in depression research (Cuijpers, Huibers, Ebert, Koole, & Andersson, 2013).

A strength of this study is that the treatment delivered was a multi-component therapy. The treatment included both sleep restriction, stimulus control and cognitive reappraisal. Inclusion of these interventions in CBT for insomnia was recommended most recently by Miller with colleagues in a review of insomnia and its treatments (Miller, Espie, & Kyle, 2014). Another strength of the study is that the treatment length and materials were exactly the same for both groups. Any differences between groups (or lack thereof) are therefore likely to be dependent on the mode of delivery.

There is increased interest in following up on adverse events in psychotherapy (Kyle et al., 2014; Rozental et al., 2014). While Rozental with colleagues provide guidelines for how to assess adverse events in Internet interventions, Kyle with colleagues investigate negative effects of sleep restriction in a sample with insomnia. In our study, adverse events in the form of subjective negative consequences of the treatment were reported for 9 participants (19%). Among these were increased worry about sleep, a minor traffic accident (according to the patient due to sleepiness during sleep restriction), increased fatigue and stress over doing the treatment. The report by Kyle et al., together with the adverse events reported here, imply that we may need to inform patients more about what to expect during the early phases of doing sleep restriction, and advice more clearly e.g. against driving. Future research needs to investigate adverse events more thoroughly, and also try to find effective treatments that minimize negative events.

Interpretations of the non-inferiority analyses must consider the relevance of the chosen non-inferiority margin. Still, the effect sizes of both treatments were convincingly large, and there can be no doubt that both ICBT and GCBT were efficacious in this study. A limitation of the study is the relatively small sample size, especially since attrition was fairly large at the six months follow-up. Future research would benefit from larger comparisons in order to generate more reliable estimates of treatment effects and indeed non-inferiority.

Participants in this study were recruited through advertisements in newspapers and on the radio, which raises the question of generalizability. Since CBT for insomnia in regular care is scarce, at best, it is difficult to make direct comparisons of the sample studied here and a population seeking regular care. There is, however, a meta-analysis of patients with depression and anxiety, comparing patients in regular care to patients in ICBT-studies (Andrews, Cuijpers, Craske, McEvoy, & Titov, 2010). They reported that symptom severity, chronicity and help-seeking patterns in the ICBT-study samples resembled characteristics of patients at regular clinics. Therapist guided ICBT for panic disorder, depression and tinnitus has transferred well from research to regular care, as is shown in several effectiveness studies (Andersson & Hedman, 2013; Hedman et al., 2014; Hedman, Ljótsson, Ruck, et al., 2013; Kaldo-Sandström, Larsen, & Andersson, 2004; Kaldo et al., 2013). Thus, even if the generalizability of the results may be somewhat limited, the contribution of ICBT to the insomnia population has the potential to be substantial, should it become available in regular care. Future studies on patients from regular clinics, as well as effectiveness studies of ICBT, are needed to determine the generalizability.

5. Conclusion

Both guided ICBT and group-delivered CBT were efficacious in this study. Effect sizes were comparatively large for insomnia severity and small to large for sleep diary data and depressive symptoms. Both treatments compared well to other studies of CBT for insomnia. Results indicate that guided ICBT was not inferior to GCBT. The results of this study are in line with previous research on ICBT and strengthen the evidence for guided ICBT for insomnia as a viable treatment alternative.

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