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Subjective–objective sleep discrepancy in patients with insomnia during and after cognitive behavioural therapy: An actigraphy study

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Summary

Although patients with insomnia often show a discrepancy between self-reported and objective sleep parameters, the role of and change in this phenomenon during treatment remain unclear. The present study aimed to assess the effect of cognitive behavioural therapy for insomnia on subjective and objective sleep discrepancy of total sleep time, sleep-onset latency and wake after sleep onset. The total sleep time discrepancy was also assessed across the entire therapy. The second aim was to examine the treatment outcome of two insomnia groups differing in sleep perception. Thirty-six adults with insomnia (mean age = 46.7 years, *SD* = 13.9; 22 females) were enrolled in the final analyses. Patients underwent a 6-week group cognitive behavioural therapy for insomnia programme. Sleep diary and actigraphy measurements were obtained during the therapy. Patients who underestimated total sleep time (*n* = 16; underestimating group) were compared with patients who accurately perceived or overestimated total sleep time (*n* = 20; accurate/overestimating group). After cognitive behavioural therapy for insomnia, a significant decrease of total sleep time and sleep-onset latency discrepancy was observed without a change in wake after sleep onset discrepancy in the total sample. Only the underestimating group reported decreased sleep-onset latency discrepancy after the treatment, whereas total sleep time discrepancy significantly changed in both groups. The underestimating group showed a significant decrease of total sleep time discrepancy from Week 1 to Week 2 when the sleep restriction was implemented, whereas the accurate/overestimating group showed the first significant change at Week 4. In conclusion, both groups differing in sleep perception responded similarly to cognitive behavioural therapy for insomnia, although different In conclusion, both groups differing in sleep perception responded similarly to cognitive behavioural therapy for insomnia, although different therapeutic components could play important roles in each group. components could play important roles in each group.

KEYWORDS

actigraphy, cognitive behavioural therapy for insomnia, insomnia, objective – subjective sleep discrepancy, sleep misperception

1 | INTRODUCTION

Insomnia is characterized by sustained complaints about difficulties in initiating and maintaining sleep or waking up earlier than desired. Daytime symptoms include attention or memory impairment, mood disturbances, daytime sleepiness or behavioural problems (AASM, 2014). Self-reported complaints of poor sleep are the main criterion for the diagnosis of insomnia. One of the reasons for subjectively based insomnia diagnostics is the wide variability in patients' objective sleep parameters. Many patients do not show objective impairment of their sleep continuity compared with self-reported evaluation (Vanable, Aikens, Tadimeti, Caruana-Montaldo, & Mendelson, 2000). Prevalence of this negative subjective and objective sleep discrepancy, or sleep misperception, ranges from 9.2% to 50%, depending on the diagnostic criteria used (Dorsey & Bootzin, 1997; Edinger & Krystal, 2003). On the other hand, not all patients with insomnia show sleep misperception. Means, Edinger, Glenn, and Fins (2003) have shown that the underestimation of total sleep time (TST) is not a generic trait of all insomnia sufferers. Moreover, some patients overestimate sleep quality compared with objective findings, which is sometimes called "positive sleep misperception" (Trajanovic, Radivojevic, Kaushansky, & Shapiro, 2007) or "positive sleep discrepancy" (Kay, Buysse, Germain, Hall, & Monk, 2015).

The first treatment choice for chronic insomnia should be cognitive behavioural therapy (CBT-I; Riemann et al., 2017). CBT-I targets maladaptive sleep habits, unhelpful beliefs and thoughts about sleep, and hyperarousal (i.e. enhanced arousal; Buysse et al., 2011; Morin & Espie, 2003). Although studies have proven the long-term effect of CBT-I (Koffel, Koffel, & Gehrman, 2015), there is nevertheless a lack of studies describing the exact mechanism of its influence on sleep. Moreover, given the variability across self-reported and objective sleep characteristics in insomnia, a clear definition of the optimal treatment outcome is missing (Morin, 2003). Most studies have used sleep diaries to measure the outcome of CBT-I (van Straten et al., 2018). However, objective sleep measures may provide additional data to improve our understanding of how CBT-I works.

One of the possible explanations of CBT-I efficacy related to sleep might be the correction of sleep misperception. In older adults, CBT-I proved to be useful in the reduction of self-reported overestimation of wake after sleep onset (WASO) and sleep-onset latency (SOL; Kay et al., 2015), as well as in the reduction of TST discrepancy (Lund, Rybarczyk, Perrin, Leszczyszyn, & Stepanski, 2013). Other therapeutic techniques apart from CBT-I may also be effective. For example, a behavioural experiment of Tang and Harvey (2004) showed promising results of reduction in sleep misperception by allowing participants to compare their self-reported estimates with actigraphic recordings. Nevertheless, the number of studies that focus on sleep discrepancy after therapeutic interventions is quite limited.

The aim of the present study was to explore changes in subjective and objective discrepancy of SOL, TST and WASO after CBT-I in adults with insomnia. Moreover, we aimed to assess changes in TST discrepancy during the entire therapeutic programme. We focused on TST because strong evidence shows many patients with insomnia underestimate the amount of sleep they obtain (Castelnovo et al., 2019). Moreover, based on a recent review, TST rather than SOL or WASO should be used when studying patients with insomnia and sleep misperception (Castelnovo et al., 2019). In the present study, a significant decrease of TST discrepancy was expected during the second week of treatment due to the sleep restriction intervention, which directly manipulated the time spent in bed (see below for more details about sleep restriction), aiming to increase sleep pressure and consolidate sleep (Kyle, Morgan, Spiegelhalder, & Espie, 2011). This change was expected to continue throughout the treatment because of the decrease in hyperarousal or anxiety symptoms due to the CBT-I components, such as relaxation and cognitive restructuring (Edinger, Wohlgemuth, Radtke, Marsh, & Quillian, 2001). On the other hand, not all patients with insomnia show negative sleep discrepancy, as mentioned before (Trajanovic et al., 2007). Thus, the treatment effect cannot be explained by the correction of sleep misperception in all people experiencing insomnia. Another objective was therefore to assess the effect of CBT-I in two insomnia subgroups defined by the presence or absence of negative sleep discrepancy. Based on previous studies, we hypothesized that CBT-I would correct underestimation of TST and overestimation of SOL (Lund et al., 2013) and WASO (Kay et al., 2015) without affecting sleep discrepancy measures in a group of patients without negative sleep misperception.

2 | MATERIALS AND METHODS

2.1 | Participants

Fifty patients diagnosed with insomnia were recruited at the Department of Sleep Medicine of the National Institute of Mental Health (NIMH), Czech Republic, and enrolled in the CBT-I group programme. Ethical approval was obtained from the local ethical committee. Insomnia diagnosis was established using the International Classification of Diseases (10th edn; WHO, 2004). Inclusion criteria were screened by physicians at NIMH's outpatients clinic and involved: (a) a minimum age of 18 years; (b) absence of severe comorbid psychiatric, neurological or somatic disease; (c) motivation to complete the CBT-I programme; (d) no or stable use of medication affecting sleep. Exclusion criteria were: (a) discontinued CBT-I programme; (b) previous experience with CBT-I without effect; or (c) night shift employment.

2.2 | Baseline measures

At the beginning of the CBT-I programme, all patients completed a battery of self-reported questionnaires to assess their sleep complaints and daytime symptoms. The battery included the Insomnia Severity Index (ISI), a seven-item questionnaire with scores ranging

TABLE 1 Structure of CBT-I sessions

1. Session	Introduction of CBT-I, education about development and maintenance of insomnia
2. Session	Setting the goals of therapy, education about circadian and homeostatic regulation of sleep, sleep restriction
3. Session	Education about sleep architecture, hyperarousal, relaxation, stimulus control
4. Session	Education about vicious cycle of insomnia and dysfunctional beliefs about sleep
5. Session	Cognitive restructuring
6. Session	Cognitive restructuring, relapse prevention, individualized recommendations

CBT-I, cognitive behavioural therapy for insomnia.

from 0 (*no insomnia*) to 28 (*severe insomnia*), reflecting the severity of insomnia symptoms, with cut-off score ≥ 8 (Bastien, Valliéres, & Morin, 2001). The Epworth Sleepiness Scale (ESS) was used to assess daytime sleepiness with cut-off score ≥ 11 suggesting clinically relevant sleepiness (Johns, 1991). The Hyperarousal Scale (HAS), empirically designed to measure daytime alertness, reflecting the enhanced arousal often found in patients with insomnia (Regestein, Dambrosia, Hallett, Murawski, & Paine, 1993) was used to measure self-reported arousal level (cut-off score > 40). Finally, a modified version of the brief World Health Organization Quality of Life questionnaire (QOL; Harper, Power, & Grp, 1998) was used to measure patients' quality of life. Participants filled in the same battery at the end of CBT-I.

2.3 | Daily measures

2.3.1 | Sleep diary

Patients were asked to complete a sleep diary every day during the 6 weeks of therapy. The questions included information about daily lights-out time, waking and rising times, self-reported estimates of SOL, number of nocturnal awakenings and WASO. Items also recorded sleep medication and rated sleep quality and daytime tiredness. The main outcomes were average SOL, TST, WASO and sleep efficiency (SE percentage = TST/time in bed) for every week. TST was calculated by subtracting the total time spent awake (SOL, WASO, and time spent awake before getting out of the bed) from the total time in bed. The leading therapist analysed diaries weekly.

2.3.2 | Actigraphy

Continuous actigraphic monitoring using a wristwatch-like device providing objective detection and quantification of a person's movement was used to assess sleep patterns objectively. The agreement with polysomnography (PSG) is about 88% (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992). Several studies have proven the sensitivity and efficacy of actigraphy in the objective measurement of treatment response in patients with insomnia (Vallieres & Morin, 2003). For the current study, the MotionWatch 8 (CamNtech) actigraphic watch was used. Patients received the devices at the beginning of CBT-I, and were asked to press the event marker every time they got in or out of bed. Participants wore actigraphs on their non-dominant wrist. Data were recorded continuously for six consecutive weeks, before they were downloaded and analysed using MotionWare 1.4 software. In the analyses of records, the recommended algorithm for sleep scoring every 60-s epoch was used (CamNtech, 2012). Event markers determined the length of time spent in bed. In the case of missing event markers, sleep diary data were used. The extracted outcomes were the same as for sleep diaries (i.e. average SOL, TST, WASO and SE per week).

2.3.3 | Objective and subjective sleep evaluation discrepancy

Discrepancy of self-reported and objective SOL, TST and WASO was computed. The Misperception Index (MI) was calculated to quantify the objective and subjective discrepancy of TST (MI = objective TST − self-reported TST/objective TST). MI ranges between +1 and −1, with positive values reflecting underestimation, negative values reflecting overestimation and zero representing accurate self-reported estimation of the selected sleep parameter (Manconi et al., 2010). SOL and WASO discrepancy was obtained by computing the difference between self-reported SOL/WASO and objective SOL/WASO (Herbert et al., 2017). Negative values reflect self-reported underestimation compared with objective measures, whereas positive values represent overestimation compared with objective findings.

2.4 | Intervention

The CBT-I intervention was led by two psychologists trained in CBT-I. The programme lasted 6 weeks and consisted of one 2-hr session per week, with five–eight patients per group. Each session had a specific structure according to the recommendations of the clinical

manual for insomnia treatment (Morin & Espie, 2003; Table 1). The first week of therapy occurred without intervening in patient' sleep schedules and thus served as a baseline. Sleep restriction, a behavioural strategy used in CBT-I to reduce time spent in bed (Morin et al., 2006), was implemented in Week 2. Patients were allowed to spend the same amount of time in bed as their average TST during the previous week. The minimum length was set at 5 hr. The sleep window was titrated every week according to average SE. If the SE was higher than 85%, then the time in bed was prolonged by 15 min. Otherwise, the time remained the same for another week.

Psychoeducation was provided at the beginning of each session. Stimulus control therapy, a set of recommendations aiming to strengthen the bed and sleep association by reducing time spent awake in bed, was set up in Week 3. The recommendations involved the following: (a) leaving the bed if one cannot fall asleep within 20 min, performing a pleasant and relaxing activity in a different room, and coming back to bed when feeling sleepy; (b) avoiding naps; (c) only using the bed and bedroom for sleep and sex. The last three sessions mainly focused on cognitive therapy (i.e. identification and reduction of dysfunctional beliefs about sleep, insomnia and its consequences).

2.5 | Statistical analyses

Statistical analyses were performed using IBM SPSS (IBM). Independent *t*-tests were used to assess differences in baseline sociodemographic, clinical and sleep parameters as well as in number of CBT-I sessions completed. Chi-squared test was used to compare group differences in the sex composition and proportion of participants with different types of insomnia complaints, insomnia severity (according to ISI score), significant daytime sleepiness (based on ESS score) and hyperarousal (based on HAS score), marital status and education. Based on data distribution, paired-samples *t*-tests or Wilcoxon signed-rank tests were used to assess differences before and after CBT-I in the total sample. Cohen's *d* was computed for effect size (Lakens, 2013).

Two-way mixed analysis of variance (ANOVA) was used to assess changes before and after the treatment within each group. For each dependent variable, Group (underestimating and accurate/overestimating) was set as a between-subject factor and Time as a within-subject factor (pre- and post-treatment). The main effects for Group, Time and the interaction of Group and Time were assessed. Partial eta square (η^2) was used for effect size (Vacha-Haase & Thompson, 2004).

To assess changes of MI during the therapy (from Week 1 to Week 6), one-way repeated-measures ANOVA was used. Multiple comparisons were corrected using the Sidak test (Sidak, 1967).

3 | RESULTS

3.1 | Participants

Because no validated quantitative criteria for sleep misperception exist (Castelnovo et al., 2019) and the degree of discrepancy varies across patients (Edinger & Fins, 1995; Tang & Harvey, 2006), we have divided the sample into two groups based on their MI to distinguish patients who underestimated sleep quantity (Manconi et al., 2010). The first group consisted of patients who underestimated their TST (MI > 0; i.e. the underestimating [UN] group). The second group comprised patients with accurate sleep perception or with a tendency to overestimate TST (MI ≤ 0; accurate/overestimating [A/O] group).

Data from 36 participants were included in the final analyses. Two subjects from the UN group discontinued CBT-I prior to the fourth session, one because of job duties and the second one because of family issues. One participant from the UN group and one from the A/O group stopped wearing their actigraphic devices before the third session because they were uncomfortable during sleep. Seven participants had to be excluded because of technical issues with actigraphs. Three patients were diagnosed with co-morbid sleep disorders (i.e. severe sleep apnea or restless legs syndrome) and were excluded from the study. Only patients with mild or moderate co-morbidities were included. Sociodemographic and clinical characteristics of the total sample are summarized in Table 2. The distribution of MI TST before and after the therapy is shown in Figure 1. Baseline differences in sociodemographic, clinical and sleep characteristics between the two groups are presented in Tables 2 and 3. A significant difference was observed in the number of patients showing severe insomnia based on the ISI score, which was higher in the UN group. No difference was found in any other questionnaire score between the groups.

As shown in Table 3, the UN group estimated sleep parameters as significantly worse than the A/O group (i.e. shorter TST, lower SE and longer WASO), whereas the groups did not differ significantly in most of the objective sleep parameters. The only difference was found in objective SE, which was higher in the UN group. A significant difference was observed in all sleep discrepancy parameters (SOL, TST and WASO) between groups.

3.2 | Treatment attendance

Three patients missed one session focused on introduction to cognitive therapy (Session 4). In the total sample, the average number of completed sessions was 5.92 (SD = 0.28), without a significant difference between the UN group (M = 5.88, SD = 0.34) and A/O group (M = 5.95, SD = 0.22), $t_{34} = -0.79$, $p = .433$. Adherence to treatment was encouraged by completing daily sleep diaries during the therapy and was controlled by therapists every session.

3.3 | Effect of CBT-I on sleep and daytime symptoms in total sample

Changes in sleep variables and daytime symptoms for the total sample can be seen in Table 4. CBT-I led to a significant reduction of ISI score, $t_{32} = 9.5$, $d = 1.68$, reflecting a decrease of insomnia severity from moderate to mild insomnia (Bastien et al., 2001). A change was

TABLE 2 Sociodemographic and clinical characteristics

	Total sample (n = 36)	UN group (n = 16)	A/O group (n = 20)	t/χ^2	p
Sex, % female	61	75	50	2.338	.126
Age (mean, *SD*)[a]	46.7 (13.9)	46.2 (11.8)	47.1 (15.8)	−0.181	.857
Length of insomnia (mean years, *SD*)[a]	5.92 (5.34)	6.39 (5.21)	5.38 (5.63)	0.513	.612
Insomnia symptoms (n):					
Sleep-onset problems	7	2	5	1.036	.309
Sleep continuity problems	15	7	8	0.010	.922
Waking up earlier than desired	1	1	0	1.222	.269
Combination	12	6	6	0.135	.713
Insomnia severity according to ISI (n):					
Mild insomnia	10	4	6	0.283	.595
Moderate insomnia	22	8	14	0.971	.324
Severe insomnia	4	4	0	5.100	**.024**
Significant daytime sleepiness based on ESS (n)	5	2	3	0.117	.732
Significant hyperarousal based on HAS (n)	14	6	8	0.169	.681
Co-morbidities (n):					
Depressive symptoms	7	5	2	0.009	.925
Anxiety symptoms	2	2	0	1.694	.193
Tinnitus	2	2	0	0.655	.418
Hypertension	5	4	1	2.973	.085
Thyroid disease	3	2	1	0.655	.418
Married (%)	50	50	45	0.330	.566
Education (%):					
Secondary school	39	44	35		
University degree	61	56	65	0.139	.710

Results of independent-samples t-tests and Chi-squared test are presented.Bold indicates a statistically significant result ($p \leq 0.05$).

A/O group, accurate/overestimating group; ESS, Epworth Sleepiness Scale; HAS, Hyperarousal Scale; ISI, Insomnia Severity Index; UN group, underestimating group.

[a]Results of independent t-test.

observed in the HAS score, which was just below the cut-off score at the beginning of CBT-I and decreased significantly after the therapy (T = 13.56, p = .039) with medium effect size (r = .39). The QOL score was significantly higher after the therapy, indicating increased quality of life (T = 102.50, p = −.038). There was no change in ESS score (T = 161, p = .712, r = .00). According to the established cut-off score, the ESS score was not clinically significant at baseline (Johns, 1991).

Self-reported SOL was significantly shorter after the therapy (T = 48, p = .000, r = .81), and self-reported SE was higher, t_{33} = −6.29, p = .000, d = −1.09, with no change in self-reported TST, t_{36} = −1.06, p = .297, d = −0.18. In case of objective parameters, CBT-I was associated with significant reduction of SOL (T = 57.00, p = .000) with large effect size (r = .81), reduction of TST, t_{34} = 5.02, p = .000, with large effect size (d = 0.86) and no significant effect on objective SE, t_{36} = −1.12, p = .369, d = −0.19. Reductions were observed in self-reported WASO, t_{32} = 2.99, p = .005, with medium effect size (d = 0.52), and objective WASO, t_{32} = 2.52, p = .017, with small effect size (d = 0.44). The SOL discrepancy was significantly lower after the treatment (T = 199.50, p = .039, d = 0.47). The same change was found in MI TST (T = 6.95, p = .000), with large effect size (d = 1.16). There was no significant difference in WASO discrepancy, t_{31} = 0.66, p = .514, d = 0.12.

3.4 | Sleep discrepancy during CBT-I in total sample

The MI of TST was found to vary across the weeks of treatment, $F_{5, 170} = 11.79$, $p < .001$, significantly decreasing from Week 1 to Week 6 ($p < .001$). Means and standard deviations are presented in Table 4.

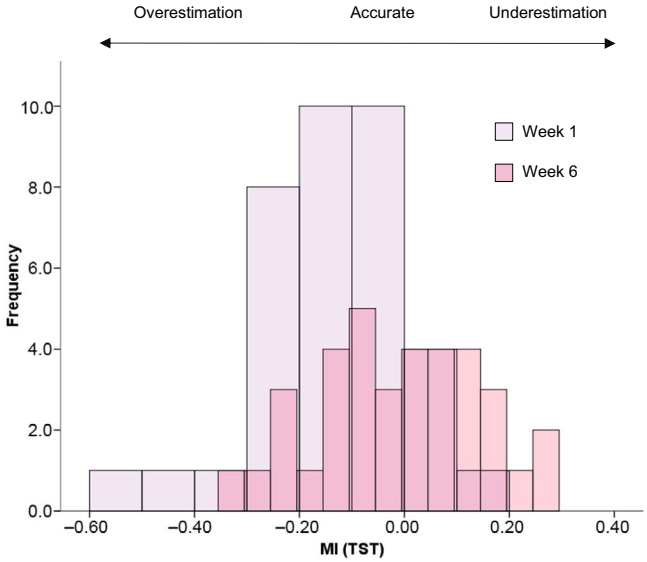

FIGURE 1 Normal distribution of MI TST in total sample at Week 1 and Week 6. MI, Misperception Index; TST, total sleep time

No significant change was observed between Week 1 (−0.01, *SD* = 0.16) and Week 2 (−0.07, *SD* = 0.16, $p = .13$). Visual presentation of MI TST changes in the total sample throughout the treatment is shown in Figure 2.

3.5 | Effect of CBT-I in the UN and A/O groups

Table 5 shows pre- to post-treatment differences in self-reported scales and questionnaires in both groups. No significant Time × Group interaction was found in any of the questionnaires. Participants in both groups reported significantly lower insomnia severity as well as lower self-reported hyperarousal and significantly higher quality of life after the treatment. A significant effect on the daytime sleepiness measure did not occur.

As shown in Table 6, significant Time × Group interaction was found in self-reported SE, WASO, objective TST and SOL discrepancy. Only the UN group showed significantly higher self-reported SE and lower self-reported WASO after the therapy, as well as shorter objective TST and lower SOL discrepancy. Both groups reported significant reductions of self-reported SOL, objective SOL and objective WASO with no change in self-reported TST. No difference in objective SE was found in either group. Both groups reported significant change of TST discrepancy after CBT-I and no change in WASO discrepancy.

TABLE 3 Baseline differences between two insomnia subgroups

	UN group	A/O group	t	p-value
Questionnaires				
ISI	18.44 (4.97)	15.61 (3.13)	2.010	**.053**
ESS	6.09 (4.66)	6.92 (4.17)	−0.544	.590
HAS	39.19 (11.89)	39.89 (8.35)	−0.201	.842
QOL	48.31 (11.9)	49.79 (8.55)	−0.426	.673
Sleep diary				
SOL (min)	48.47 (32.68)	33.11 (20.63)	1.701	.098
TST (min)	330.56 (58.38)	388.44 (46.74)	−3.306	**.003**
SE (%)	67.08 (7.86)	80.01 (6.27)	−5.419	**.000**
WASO (min)	61.00 (46.60)	28.27 (22.08)	2.882	**.007**
Actigraphy				
SOL (min)	11.58 (8.84)	17.82 (15.07)	−1.463	.153
TST (min)	372.73 (33.51)	347.73 (43.40)	1.808	.080
SE (%)	77.26 (4.68)	71.96 (5.99)	2.897	**.007**
WASO (min)	97.57 (26.07)	108.68 (35.24)	−0.994	.328
Sleep discrepancy				
SOL (min)	34.75 (34.52)	15.29 (20.58)	2.100	**.043**
WASO (min)	−41.35 (48.92)	−80.71 (38.95	2.574	**.015**
TST (MI)	0.13 (0.08)	−0.13 (0.09)	8.681	**.000**

Results of independent-samples *t*-tests are presented.Bold indicates a statistically significant result ($p \leq 0.05$).

A/O group, accurate/overestimating group; ES, Cohen's *d* for paired *t*-test, *r* for Wilcoxon test; ESS, Epworth Sleepiness Scale; HAS, Hyperarousal Scale; ISI, Insomnia Severity Index; MI, Misperception Index; QOL, Quality of Life scale; SE, sleep efficiency; SOL, sleep-onset latency; TST, total sleep time; UN group, underestimating group; WASO, wake after sleep onset.

TABLE 4 Pre- to post-treatment differences in total sample

Total sample (n = 36)				
	Pre-treatment	Post-treatment	*p*-value	ES
Questionnaires				
ISI	16.9 (4.3)	9.8 (3.7)	**.000**	**1.68**
ESS[a]	6.5 (4.4)	6.4 (4.1)	.712	0.00
HAS[a]	39.6 (10)	36.2 (10.1)	**.039**	**0.39**
QOL[a]	49.1 (10.1)	54.1 (10.6)	**.003**	**−0.38**
Sleep diary				
SOL (min)[a]	39.7 (27.1)	19.5 (7.3)	**.000**	**0.81**
TST (min)	362.7 (59.1)	369.4 (48.5)	.297	−0.18
SE (%)	75.3 (9.1)	86.3 (7.6)	**.000**	**−1.09**
WASO (min)	41.16 (38.24)	24.60 (18.41)	**.005**	**0.52**
Actigraphy				
SOL (min) [a]	15 (12.9)	8.9 (9.5)	**.000**	**0.49**
TST (min)	358 (41)	323.9 (34.7)	**.000**	**0.86**
SE (%)	74.3 (6)	75.3 (5.3)	.269	−0.19
WASO (min)	103.96 (31.71)	90.04 (21.86)	**.017**	**0.44**
Sleep discrepancy				
SOL (min) [a]	23.9 (28.9)	11.4 (12.2)	**.036**	**0.47**
WASO (min)	−65.3 (47.23)	−69.88 (25.47)	.514	0.12
TST (MI)	−0.01 (0.16)	−0.16 (0.14)	**.000**	**1.16**

Results of paired-sample *t*-tests, Wilcoxon Signed Ranks Test and Cohen's *d* and *r* for effect size are presented.Bold indicates a statistically significant result (p ≤ 0.05).

ES, Cohen's *d* for paired *t*-test, *r* for Wilcoxon test; ESS, Epworth Sleepiness Scale; HAS, Hyperarousal Scale; ISI, Insomnia Severity Index; MI, Misperception Index; QOL, Quality of Life scale; SE, sleep efficiency; SOL, sleep-onset latency; TST, total sleep time; WASO, wake after sleep onset.

[a]Wilcoxon Signed Ranks Test, *r* for effect size is presented.

3.6 | Sleep discrepancy during CBT-I in UN and A/O groups

In the UN group, the MI of TST varied across the weeks of treatment, $F_{5,70}$ = 12.44, p < .001, with a significant decrease from Week 1 (+0.14, *SD* = 0.08) to Week 2 (+0.02, *SD* = 0.15, p = .048). The MI of TST in the A/O group also varied across the weeks of CBT-I, $F_{5,95}$ = 2.93, p < .05, but there was no significant change of MI from Week 1 (−0.13, *SD* = 0.09) to Week 2 (−0.15, *SD* = 0.13, p = .99). Changes of MI in both groups are visualized in Figure 2.

4 | DISCUSSION

Across the sample, CBT-I was associated with a significant reduction of SOL discrepancy. There was no change in WASO discrepancy; both self-reported and objective WASO were shorter after the treatment. The result is in line with Lund et al. (2013), who reported less prominent change in WASO compared with SOL discrepancy after CBT-I. In the present study, objective TST was significantly reduced with no change in self-reported TST, leading to an overestimation of objective sleep duration. The reduction of objective TST after CBT-I has been reported in previous studies (Edinger, Wohlgemuth, Radtke, Coffman, & Carney, 2007) as a possible consequence of sleep restriction (Kyle et al., 2014). Contrary to our hypothesis, the first significant change of TST discrepancy in the total sample was observed in Week 3. The TST discrepancy values were normally distributed in both Week 1 and Week 6, which is in contrast to previous studies attributing a more accurate perception of sleep (Manconi et al., 2010) or even overestimating sleep quality to people without insomnia (O'Donnell et al., 2009). The usage of different objective sleep measures could contribute to such a contrary result. Studies have suggested actigraphy underestimates TST compared with PSG (Vallieres & Morin, 2003). Nevertheless, the results of the present study are in line with previous actigraphy research assessing CBT-I efficacy (Kay et al., 2015).

Both groups responded similarly to CBT-I based on self-reported questionnaires and most of the sleep measures. Contrary to our hypothesis, both UN and A/O groups showed significant change in MI of TST. Only the UN group reported significant reduction of SOL discrepancy, which is in line with previous research (Cronlein et al., 2019; Kay et al., 2015; Lund et al., 2013). The UN group also reported increased self-reported SE and decreased self-reported WASO. Baseline differences in self-reported sleep parameters between groups could contribute to different magnitudes of change in these sleep measures. The UN group showed significantly lower sleep quality based on sleep diary parameters, greater sleep discrepancies, and involved a higher proportion of patients with severe insomnia compared with the A/O group, which could increase the probability of greater change (Jin, 1992).

Several CBT-I components could have affected sleep discrepancies. In the UN group, the change of TST mismatch could have been caused by a significant shortening of objective sleep duration after CBT-I as a consequence of sleep restriction (Kyle et al., 2014). This assumption was further supported by a significant change of MI TST from Week 1 to Week 2, when the sleep restriction was implemented. The sleep restriction could result in a more significant change of patients' objective TST in the UN group compared with the A/O group. The UN group's underestimation of sleep duration at the beginning of treatment could lead to a stricter sleep window, increased sleep pressure, more consolidated sleep (Kyle et al., 2014) and the subsequent correction of sleep misperception, which would be in line with Maric, Burgi, Werth, Baumann, and Poryazova (2019). Although not observed in patients with insomnia, this study showed

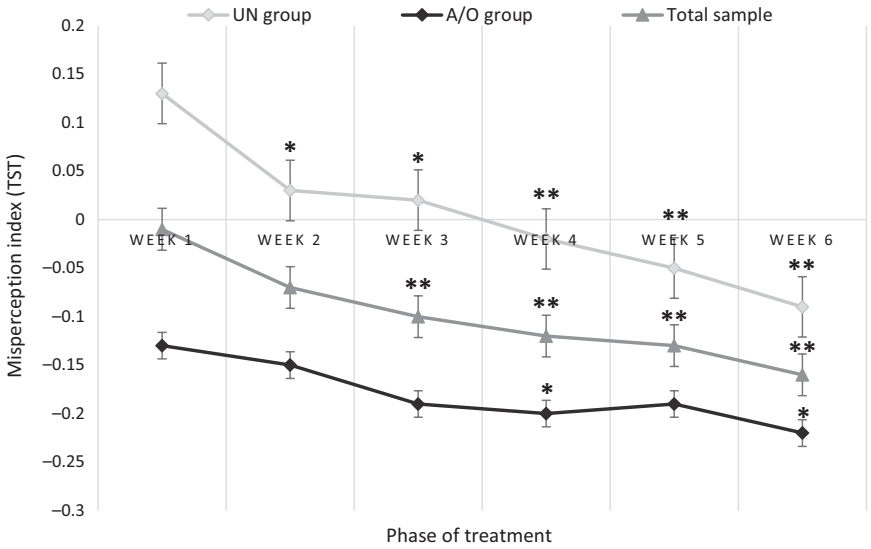

FIGURE 2 Changes of MI TST (mean) during the CBT-I in total sample, UN group and A/O group. A/O group, accurate/overestimating group; CBT-I, cognitive behavioural therapy for insomnia; MI, Misperception Index; TST, total sleep time; UN group, underestimating group. *$p \leq .05$, **$p \leq .01$ for comparison with Week 1

that underestimation of TST shifted towards overestimation during sleep restriction in healthy volunteers (Maric et al., 2019). However, this cannot fully explain the shift from accurate estimation to overestimation of TST in the A/O group. Because CBT-I involves several different techniques, other interventions should be taken into account.

Psychoeducation and cognitive techniques aim to alter dysfunctional beliefs about sleep (Edinger et al., 2001), eliminate maladaptive sleep habits and improve sleep quality (Morin, Stone, Trinkle, Mercer, & Remsberg, 1993). CBT-I has been shown to reduce dysfunctional beliefs about sleep, and these changes have been associated with improvements in objective and self-reported sleep measures (Edinger et al., 2001). Therefore, cognitive therapy could have contributed to the A/O group's overestimation of TST in the present study. However, because we did not involve measurement of dysfunctional beliefs about sleep, we cannot make any conclusions. Moreover, studies focusing on the relation between cognitive changes and sleep discrepancy are lacking in general. A sparse amount of evidence suggests that typical cognitive therapy within CBT-I has no significant effect on sleep misperception (Lund et al., 2013). Patients who underestimate their sleep could therefore benefit more from specific education about sleep discrepancy (Cronlein et al., 2019), and from verbal feedback or behavioural

TABLE 5 Pre- to post-treatment differences in subjective scales and questionnaires in UN and A/O groups

Condition	Pre-treatment	Post-treatment	Main effects	*df*	$F_{1,34}$	*p*	ES (η^2)
ISI							
UN group	18.4 (4.9)	10.3 (3.7)	Time	1, 30	91.902	**.000**	**0.754**
A/O group	15.6 (3.1)	9.4 (3.7)	Group		2.301	.140	0.071
			Time × Group		1.210	.280	0.039
ESS							
UN group	6.1 (4.7)	6.7 (4.8)	Time	1, 31	0.019	.891	0.001
A/O group	6.9 (4.2)	6.1 (3.5)	Group		0.041	.841	0.001
			Time × Group		2.292	.140	0.069
HAS							
UN group	39.2 (11.9)	35.1 (10.6)	Time	1, 31	5.504	**.032**	**0.140**
A/O group	39.9 (8.4)	37.2 (9.9)	Group		0.182	.672	0.006
			Time × Group		0.183	.672	0.006
QOL							
UN group	48.3 (11.9)	54.2 (12.1)	Time	1, 31	6.447	**.016**	**0.172**
A/O group	49.8 (8.6)	54.1 (9.6)	Group		0.067	.789	0.002
			Time × Group		0.200	.658	0.006

Results of two-way mixed ANOVA and partial eta square (η^2) for effect size are presented, means (*SD*).Bold indicates a statistically significant result ($p \leq 0.05$).

A/O group, accurate/overestimating group; ES, effect size; ESS, Epworth Sleepiness Scale; HAS, Hyperarousal Scale; ISI, Insomnia Severity Index; QOL, Quality of Life scale; UN group, underestimating group.

TABLE 6 Pre- to post-treatment differences in objective and subjective sleep parameters in UN and A/O groups

Condition	Pre-treatment	Post-treatment	Main effects	*df*	*F*	*p*	ES (η^2)
Sleep diary							
SOL (min)							
UN group	51.00 (34.53)	23.15 (5.33)	Time	1, 31	21.953	**.000**	**0.415**
A/O group	33.11 (20.62)	16.80 (7.38)	Group		5.550	**.025**	**0.152**
			Time × Group		1.497	.230	0.046
TST (min)							
UN group	330.56 (58.38)	334.7 (37.2)	Time	1, 34	0.999	.325	0.029
A/O group	388.40 (46.70)	397.30 (37.60)	Group		19.072	**.000**	**0.359**
			Time × Group		0.134	.726	0.004
SE (%)							
UN group	67.1 (7.9)	83.5 (7.9)	Time	1, 31	47.766	**.000**	**0.606**
A/O group	80 (6.3)	88.2 (6.7)	Group		20.268	**.000**	**0.395**
			Time × Group		4.362	**.045**	**0.123**
WASO (min)							
UN group	61.00 (49.25)	30.69 (23.04)	Time	1, 31	12.446	**.001**	**0.286**
A/O group	28.27 (22.08)	20.65 (13.91)	Group		6.510	**.016**	**0.174**
			Time × Group		4.453	**.043**	**0.126**
Actigraphy							
SOL (min)							
UN group	11.6 (8.8)	8.5 (11.8)	Time	1, 34	7.681	**.009**	**0.184**
A/O group	17.8 (15.1)	9.1 (7.4)	Group		1.202	.281	0.034
			Time × Group		1.754	.194	0.049
TST (min)							
UN group	372.7 (33.5)	316.3 (36.8)	Time	1, 32	39.220	**.000**	**0.551**
A/O group	347.7 (43.4)	330.3 (35.8)	Group		0.168	.685	0.005
			Time × Group		11.370	**.002**	**0.262**
SE (%)							
UN group	77.3 (4.7)	77.8 (4.8)	Time	1, 34	1.119	.297	0.032
A/O group	71.9 (5.9)	73.2 (4.8)	Group		11.034	**.002**	**0.245**
			Time × Group		0.158	.694	0.005
WASO (min)							
UN group	97.57 (26.07)	72.60 (11.27)	Time	1, 31	8.069	**.008**	**0.207**
A/O group	108.68 (35.24)	102.88 (18.64)	Group		8.751	**.006**	**0.220**
			Time × Group		3.134	.087	0.092
SOL discrepancy (min)							
UN group	34.75 (34.52)	15.96 (13.38)	Time	1, 34	68.775	**.000**	**0.669**
A/O group	15.29 (20.58)	7.67 (10.12)	Group		6.253	**.017**	**0.155**
			Time × Group		11.904	**.002**	**0.259**
WASO discrepancy (min)							
UN group	−41.35 (48.92)	−49.64 (17.63)	Time	1, 30	0.475	.496	0.016
A/O group	−80.71 (38.95	−83.73 (20.29)	Group		13.242	**.001**	**0.306**
			Time × Group		0.072	.790	0.002
TST discrepancy (MI)							
UN group	0.13 (0.1)	−0.1 (0.1)	Time	1, 34	8.816	**.005**	**0.206**
A/O group	−0.13 (0.1)	−0.2 (0.1)	Group		37.122	**.000**	**0.522**
			Time × Group		1.572	.219	0.044

Results of two-way mixed ANOVA and partial eta square (η^2) for effect size are presented, means (*SD*).Bold indicates a statistically significant result ($p \leq 0.05$).

A/O group, accurate/overestimating group; ES, effect size; MI, Misperception Index; SE, sleep efficiency; SOL, sleep-onset latency; TST, total sleep time; UN group, underestimating group; WASO, wake after sleep onset.

experiments focused on the discrepancy between their sleep diaries and objective sleep measures (Tang & Harvey, 2006). However, this should be applied primarily in misperceiving patients. For patients who overestimate sleep quantity, objective feedback may not be beneficial or may be even harmful. In fact, Gavriloff et al. (2018) showed that negative feedback about sleep can adversely affect patients' perceptions of daytime functioning. This can subsequently trigger distress through cognitive processes and exacerbate sleep impairment (Harvey, 2002). Indeed, although the objective sleep continuity parameters did not improve significantly in the present study, the treatment outcome was associated with improvement in most of the questionnaires. The severity of insomnia decreased significantly from moderate to mild, and a reduction of self-reported hyperarousal and increased quality of life was observed for the total sample and the two subgroups. Only the daytime sleepiness scale score remained unchanged after the therapy. However, the score was not clinically significant at the beginning of treatment (Johns, 1991).

Several limitations of the present study should be mentioned. First, we did not include a control group of patients undergoing a different type of treatment or remaining untreated. Thus, we cannot conclude with certainty that the observed effect was caused only by CBT-I. Second, our results could have been biased by the fact that we did not involve patients who dropped out of the treatment in the final analysis. As such, we did not conduct an intent-to-treat analysis because the aim was to measure the effect of treatment in patients who adhered to the programme. Third, actigraphy could potentially underestimate objective TST compared with PSG (Vallieres & Morin, 2003), which could have biased our data. However, actigraphy is a home-environment and low-cost measurement compared with PSG, and it allowed us to measure patients' activity every day during the treatment. To date, no study has measured sleep discrepancy during an entire CBT-I programme. Fourth, sleep diaries were analysed by a leading therapist and not by an independent researcher, which also could have biased our data. Finally, further distinguishing patients in the A/O group (i.e. patients with accurate estimates of sleep and patients who overestimate sleep quantity) might yield more accuracy when studying their perceptions of their sleep. Future studies could involve PSG to examine other objective changes in sleep and their relation to subjective perception, not only in patients who underestimate (Cronlein et al., 2019), but also in patients who overestimate their sleep quantity after the treatment. This could further promote a better understanding of insomnia treatment and the disorder itself.

In summary, the present study was the first to assess the effect of CBT-I on subjective and objective sleep discrepancy during an entire therapeutic programme. We further confirmed that CBT-I was associated with a reduction of TST and SOL discrepancy. Both groups differing in sleep perception responded similarly to CBT-I, although different CBT-I components could play an important role in each group. Only the UN group showed a significant decrease of TST discrepancy from Week 1 to Week 2 when the sleep restriction was implemented, whereas the A/O group showed the first significant change at Week 4. We propose that patients with insomnia who overestimate sleep quantity should be taken into account by future studies to further explore whether the treatment effect is associated with more subtle objective sleep changes, or whether cognitive processes play a more important role in this group.

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CONFLICT OF INTEREST

No conflicts of interest declared.

AUTHOR CONTRIBUTIONS

K.J. and J.K. conceived the original idea, and planned and carried out the study. K.J. and M.Š. led CBT-I groups and performed statistical analyses. E.F. analysed actigraphic data and contributed to the interpretations of the results. K.J. wrote the first draft of the manuscript. J.K. supervised the project and provided guidance in writing the manuscript. All authors provided critical feedback, and helped to shape the research and final manuscript.

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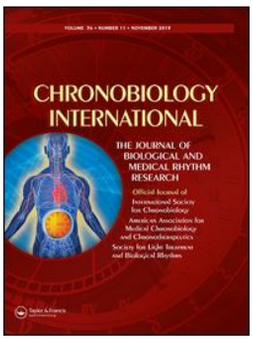

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Block the light and sleep well: Evening blue light filtration as a part of cognitive behavioral therapy for insomnia

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Block the light and sleep well: Evening blue light filtration as a part of cognitive behavioral therapy for insomnia

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ABSTRACT

The objective of the present study was to assess the effect of combining CBT-I with wearing blue-light blocking glasses 90 min prior to bedtime on subjective and objective sleep parameters and daily symptoms (anxiety, depression, hyperarousal). Thirty patients (mean age 48.1 ± 16.13 years, range 21–71, 15 men/15 women) completed a CBT-I group therapy program, with groups randomly assigned to either "active" (blue-light filtering glasses) condition or "placebo" (glasses without filtering properties) condition. Patients were continually monitored by wristwatch actigraphy, kept their sleep diaries and completed a standard questionnaire battery at admission and after the end of the program. Statistical analyses showed a greater reduction of BAI score in "active" (4.33 ± 4.58) versus "placebo" (−0.92 ± 3.68) groups of patients [F = 6.389, p = .019, Cohen's d = 1.26] and significant prolongation of subjective total sleep time in "active" (−36.88 ± 48.68 min.) versus "placebo" (7.04 ± 47.50 min.) [F = 8.56, p < .01, d = 0.91] group. When pre- and post-treatment results were compared in both groups separately, using paired-samples t-tests, significant differences were observed also in the active group for BDI-II score (t = 3.66, p = .003, Cohen's d = 0.95) and HAS score (t = 2.90, p = .012, Cohen's d = 0.75). No significant differences were found in the placebo group. In active group, there was also a significant reduction of subjective sleep latency (t = 2.65, p = .021, d = 0.73) and an increase of subjective total sleep time (t = −2.73, p = .018, d = −0.76) without change in objective sleep duration which was significantly shortened in the placebo group. We provide further evidence that blocking short-wavelength light in the evening hours may be beneficial for patients suffering from insomnia.

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1. Introduction

Insomnia is one of the most common sleep disorders occurring in approximately 6% to 10% of adult population (Ohayon 2002). Chronic insomnia can lead to several negative health and socioeconomic consequences such as increased risk of depression or anxiety, somatic diseases and higher absenteeism (Chilcott and Shapiro 1996). One of the most effective treatments for insomnia is cognitive behavioral therapy (CBT) (Riemann et al. 2017) which aims to change maladaptive sleep habits, unhelpful beliefs and thoughts about sleep, and hyperarousal (i.e. enhanced arousal). Although its efficacy has been proven by a number of studies (Morin et al. 2006) there is still a certain percentage of patients (19–26%) who do not respond to this treatment (Murtagh and Greenwood 1995). Moreover, there is no clear evidence that the CBT for insomnia (CBT-I) has an effect on objective sleep parameters as studies assessing both subjective and objective sleep characteristics have shown a stronger impact of CBT-I on subjective sleep quality compared to objective measure (Okajima et al. 2011). Thus, further research is needed to examine other therapeutic interventions to enhance its efficacy. It is also a clinically relevant need to examine alternative interventions to CBT-I or sleep restriction as in some patients, the sleep restriction therapy can lead to sleep deprivation and related negative side effects, such as increased sleepiness or significantly reduced sleep duration at the acute phase of treatment (Kyle et al. 2014).

Sleep hygiene, a set of behavioral and environmental recommendations is a standard part of CBT-I (Morin et al. 2006). In a recent review, Irish et al. (Irish et al. 2015) reported that caffeine, tobacco and alcohol use, exercise, stress, noise, timing of sleep, and daytime napping are the areas commonly covered during sleep hygiene education. Unfortunately, small to none attention is paid to the "light hygiene" – a set of rules and recommendations to mitigate the

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negative impact of evening/night screen exposure on sleep quality. This would be hypothesized to ameliorate the impact of light on a circadian system by preventing light-induced melatonin suppression, leading to reduced phase-delaying effect of light and decreasing cortical arousal (Rodriguez-Morilla et al. 2017; Sasseville et al. 2006). With regards to the evening and nighttime exposure to short-wavelength light, several interventions with possible chronotherapeutic properties have been proposed, although RCTs (randomized controlled trials) are currently lacking (Lawrenson et al. 2017).

Many investigators have shown that blue-light shield eyewear is a feasible and acceptable tool (Perez Algorta et al. 2018) able to reduce sleep and circadian dysregulation (Ayaki et al. 2016; Heo et al. 2017) and improve neuropsychological functioning (van der Lely et al. 2015; Zimmerman et al. 2019). Apart from insomnia (Shechter et al. 2018), some studies even focused on using "dark therapy" to treat mental disorders associated with sleep problems, such as major depressive disorder or bipolar disorder (Esaki et al. 2017; Henriksen et al. 2016). Other methods, such as software filters (e.g. f.lux®, Iris®, Twilight®) and system features (night or reading modes) reducing the amount of blue light emitted from screens are freely available for the most used mobile platforms, their research application is, however, very sparse (Heath et al. 2014). Could these simple and easy-to-use interventions be the missing link to increase the efficacy of CBT-I treatment programs or an appropriate alternative to this treatment?

Building on recent research (Shechter et al. 2018; Zimmerman et al. 2019) the aim of this randomized controlled trial was to for the first time assess the effect of CBT-I in combination with blue-light-blocking glasses (BB glasses). A CBT-I group with active glasses was compared with a CBT-I group wearing clear placebo glasses. We expected to find improvement in sleep parameters in both groups with a larger effect in the group with active glasses.

2. Materials and methods

2.1. Participants

Forty-five patients diagnosed with insomnia were recruited at the Department of Sleep Medicine of the National Institute of Mental Health, Czech Republic and enrolled in the CBT-I group program. Ethical approval was obtained from a local Ethical Committee. Insomnia diagnosis was established on the International Classification of Diseases, 10th edition (World Health Organization 2004). Inclusion criteria were: (a) minimum age of 18 years; (b) absence of severe comorbid psychiatric, neurological or somatic disease; (c) motivation to complete CBT-I program; (d) stable usage of medication affecting sleep. Exclusion criteria were: (a) interrupted CBT-I program; (b) previous experience with CBT-I; (c) night shifts.

2.2. Subjective sleep measures

All patients were asked to complete a sleep diary every day during the therapy. The sleep logs included reports of daily lights-out time, waking and rising times, subjective estimates of sleep latency, number of nocturnal awakenings and wake after sleep onset. There were also items recording sleep medication and ratings of sleep quality and daytime tiredness. The main outcomes were average SOL, TST, wake after sleep onset (WASO) and sleep efficiency: SE % = (time in bed/total sleep time) * 100 for every week. The diary was analyzed weekly by the leading therapist.

Patients completed a battery of self-reported questionnaires to assess sleep complaints and daytime symptoms at the beginning and at the end of CBT-I. The battery included the following questionnaires.

2.2.1. The Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) (Buysse et al. 1989) was used to assess sleep habits and sleep quality in the preceding 2 weeks. The measure consists of 19 individual items, creating seven components that produce one global score, and takes 5–10 min to complete. The score ranges between 0 and 21 and 6 is considered a cutoff score for significant insomnia symptoms. Although the PSQI is routinely used in clinical practice in the Czech Republic, no study so far has examined its psychometric properties.

2.2.2. Insomnia Severity Index (ISI)

Insomnia Severity Index (ISI) is a 7-item questionnaire measuring the patients´ perception of their insomnia, with scores ranging from 0 (no insomnia) to 28 (severe insomnia), with 8 as a cutoff. It is

a reliable and valid method to quantify the perceived severity of insomnia symptoms and consequences resulting from described difficulties (Bastien et al. 2001).

2.2.3. Sheehan Disability Scale (SDS)

Sheehan Disability Scale (SDS) was used to measure daytime functioning impairment. This scale uses visual-spatial, numeric and verbal descriptive anchors to assess disability across three domains: work, social life, and family life. The SDS has proved to be very sensitive to change in drug treatment studies in psychiatry (Sheehan et al. 1996). The scores range from 0 to 30 with no formally recommended cutoff score.

2.2.4. Epworth Sleepiness Scale (ESS)

To measure daytime sleepiness the Epworth Sleepiness Scale (ESS) was administered. It is a self-administered questionnaire including questions on eight situations which could be very soporific for some people. Patients are asked to rate how likely they would fall asleep in presented situations in recent times on scale ranging from 0 to 3 with a maximum total score of 24 and a recommended cutoff of 11 points. The validation study has proved its ability to distinguish normal subjects from patients with various diagnoses such as obstructive sleep apnea syndrome or narcolepsy (Johns 1991).

2.2.5. Beck Depression Inventory-2 (BDI-II)

Beck Depression Inventory-2 (BDI-II) is a diagnostic tool measuring the symptoms of depression and their severity (Beck et al. 1961). It contains 21 items with a scale ranging from 0 to 3 for answers. The items include several depressive symptoms such as affective, cognitive, motivational or physiological symptoms. The total score range is between 0 and 63 with 10 points indicating mild depression.

2.2.6. Beck Anxiety Inventory (BAI)

Beck Anxiety Inventory (BAI) (Beck and Steer 1993) is a self-administered questionnaire measuring actual symptoms of anxiety. The 21 items include several somatic and psychologic symptoms of anxiety. A participant is asked to answer on 0–3 scale how often the present symptom has bothered her/him during the last week. Total score ranges between 0 and 63 and a cutoff of 8 is usually used to indicate mild anxiety.

2.2.7. Hyperarousal Scale (HAS)

Hyperarousal Scale (HAS), a 26-item empirically designed to measure daytime alertness reflecting the enhanced arousal (i.e. hyperarousal) often found in insomnia patients was also used in the present study to assess daytime insomnia-related symptoms (Regestein et al. 1993). The total score ranges from 0 to 73, with a score above 40 indicating increased arousal typical for insomnia.

2.3. Actigraphy

Actigraphy is a noninvasive wristwatch-like device recording sleep and wakefulness patterns. It measures physical activity throughout the day. The movements reflect the phase of wakefulness, their absence reflects a period of sleep. Several studies have already demonstrated its sensitivity and clinical use in an objective measurement of treatment response in patients with chronic insomnia (Vallieres and Morin 2003). For the current study, the MotionWatch 8 (CamNtech Ltd., Cambridge, UK) actigraphic watch was used. Patients received the devices at the beginning of CBT-I and were asked to press the event marker every time they went in or out of bed. Participants wore actigraphs on their non-dominant wrist. Data were recorded continuously for six consecutive weeks before they were downloaded and analyzed by a researcher blinded to the experimental condition using MotionWare 1.4 (CamNtech). In the analyses of records, the recommended algorithm for sleep scoring every 60 s epoch was used. The time in bed period was determined by either event markers or sleep diaries. The extracted outcomes were the same as for sleep diaries, i.e. average SOL, TST, WASO, and SE per week for baseline and post-treatment comparison, including both free days and working days, as the sleep restriction regime set was the same for free- and working days.

2.4. Interventions

2.4.1. CBT-I

The group CBT-I program was led by two educated psychologists. The length of the program was 6 weeks, with a 2-h session per week. One group consisted of 5 to 8 patients and one therapist. Each

session had a specific structure according to the recommendations of the clinical manual for insomnia treatment (Morin and Espie 2003). In the second week of treatment, the sleep restriction was set up. Sleep restriction is one of the main behavioral strategies used in CBT-I aiming to reduce patients´ time spent in bed. Patients were recommended to spend the same amount of time in bed as was their average TST during the previous week. The minimum length of TST was set up at 5 h. This sleep window was titrated every week based on the following rule: if the sleep efficiency was higher than 85%, the time in bed was prolonged by 15 min. Otherwise, the time remained the same for another week.

2.4.2. Blue-light blocking glasses

For the active condition, the UVEX S1933X (US certification ANSI Z87 + and CSA Z94.3) orange glasses were given to patients. Based on the used spectrum control technology they were supposed to reduce up to 98% of the lights of blue wavelength. As the placebo condition the UVEX S1900 (US certification ANSI Z87 + and CSA Z94.3) clear glasses with no ability to filtrate blue light were used. Patients of both groups were instructed to wear the glasses 90 min prior to scheduled bedtime from week 2 till the end of the program. A separate item was added to the sleep diary for the patients to report the usage of glasses every evening to enhance their compliance. No adverse effects were reported by the patients.

2.5. Procedure

A flow of enrollment and allocation of participants is presented in Figure 1. At the first CBT-I session participants were asked to fill in the questionnaires and received the actigraphs. The first week served for baseline measurement as the first interventions were conducted at week 2. At the second session, patients were given either active glasses (BB glasses) or placebo glasses. Patients in one group had the same type. They were told that the study is focused on several types of glasses with different filtration properties. The instruction was to wear the glasses every day of the treatment at least 90 min before bedtime. To increase the compliance, patients were repeatedly educated about light hygiene and were asked to report usage of glasses in sleep diaries every day.

2.6. Statistical analyses

A sample size calculation was performed before the study began using a large effect size (d = 0.90) with $\alpha = 0.05$. To detect significant differences in

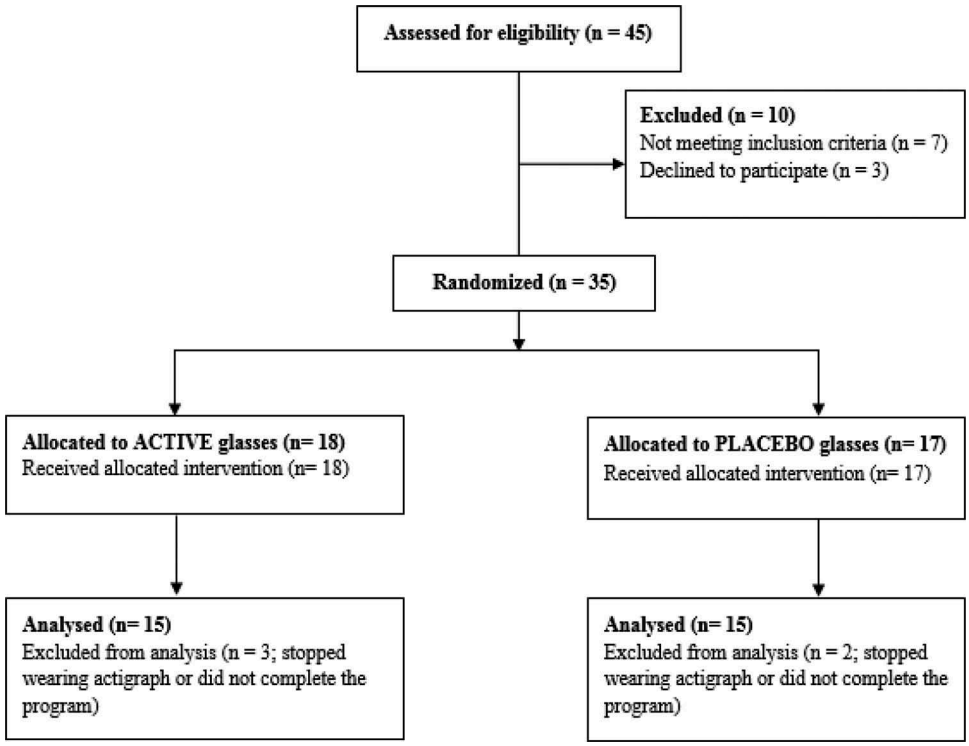

Figure 1. CONSORT diagram of study flow.

subjective sleep parameters (SOL, SE, TST) before and after the therapy the suggested sample size was n = 6–9 in each group (Cervena et al. 2004; Koffel et al. 2015). For detection of differences in objective sleep parameters measured by actigraphy at least eight patients were suggested (Vallieres and Morin 2003). As such, we aimed to include 30 patients in total, 15 patients in each group.

Firstly, independent-samples t-tests were used to compare both groups at baseline. Next, a General Linear Model (GLM) was used to compare differential values (of pre- to post-treatment change) between both studied groups with age, gender and leading therapist set as covariates. Lastly, paired t-tests were used to assess changes for each variable separately within each group. IBM SPSS Statistics software (v 23.0) was used for analyses.

3. Results

3.1. Participant characteristics

Of 45 patients enrolled in the CBT-I program, 7 participants did not meet inclusion criteria and 3 declined to participate (Figure 1). After the randomization of groups, 5 patients refused to continue wearing the actigraph or did not complete the program. A final sample of 30 participants was involved in the analyses (50% female). The basic characteristics of the final sample can be seen in Table 1. As the age difference between groups reached the threshold of statistical significance [$t(28) = -2.052$, $p = .050$], age was used as a confounding variable in further analyses along with gender and assigned therapist.

To compare both groups at the beginning of the CBT-I program, independent-samples t-tests were carried out for all variables, including ISI, PSQI, ESS, SDS, HAS, BDI and BAI questionnaires and both subjective and objective measures of sleep parameters (SOL, TST, WASO, SE). Baseline measures in each group are presented in Table 2. The only statistically significant difference between the active and placebo group was found for sleepiness (as measured by ESS) (t = 2.437, $p = .021$), with higher score (indicating more sleepiness) found in the active group (8.17 ± 4.22) as compared to the placebo group (4.73 ± 3.45). Despite significance, the value was well below the cutoff score for clinically relevant sleepiness in both groups (Johns 1991).

Table 1. Distribution of male/female participants in CBT-I groups with their age (mean ± SD).

	Total sample	Active group	Placebo group
n	30	15	15
Female/Male	15/15	6/9	9/6
Age	48.1 ± 16.1	42.4 ± 14.8	53.9 ± 15.8
Lenght of insomnia (years)	5.32 ± 5.07	6.33 ± 6.62	4.38 ± 2.68
Married (%)	50%	46%	53%
Education (%):			
High school	26%	15%	36%
University degree	74%	85%	64%

3.2. Pre- to post-treatment differences between groups

As a next step, differential values for questionnaire scores (pre-minus post-treatment value) were calculated, reflecting the change in scores reached after finishing CBT-I groups (as compared to baseline). Differences for both groups were then compared (using a GLM), finding statistically significant difference in BAI score [$F(1, 22) = 6.389$, $p = .019$, Cohen's $d = 1.26$], with a larger decline in anxiety score in the active group (6.73 ± 4.15) as compared to the placebo group (5.91 ± 4.32), for illustration see Figure 2. Furthermore, when looking at the levels of anxiety pre- and post-treatment, we decided to compare BAI components: somatic anxiety, subjective anxiety and autonomic anxiety (based on a factor analysis by Lee et al. (2018)). A statistically significant decrease was found for Subjective anxiety [$t(12) = 3.570$, $p = .004$] and a trend toward decrease for Somatic anxiety factor [$t(10) = 2.136$, $p = .058$] in the active glasses group, but not in the group with placebo glasses. The autonomic anxiety factor's scores remained unchanged in both groups. Differences in all other questionnaire scores were found to be insignificant and can be found in Table 3.

Following analyses of questionnaire scores, comparison of the differential values of both objective and subjective sleep parameters in active and placebo groups was carried out. A statistically significant difference was found for subjective total sleep time [$F(1, 22) = 8.565$, $p = .008$, Cohen's $d = 0.91$], resulting in approximately 44 min longer TST in the active group as compared to the placebo group

Table 2. Baseline characteristics of the active and placebo groups.

	Active (n = 15)	*Placebo (n = 15)*	*t*	*p*
Baseline Values				
ISI	17.26 ± 5.42	17.20 ± 3.23	0.041	0.968
PSQI	12.60 ± 4.36	13.33 ± 3.46	−0.511	0.614
ESS	8.17 ± 4.22	4.73 ± 3.45	2.437	0.021
SDS	18.97 ± 11.34	15.27 ± 10.12	0.943	0.354
HAS	41.60 ± 8.40	37.07 ± 10.42	1.312	0.200
BDI	15.13 ± 12.05	13.47 ± 9.78	0.416	0.681
BAI	10.80 ± 5.88	12.93 ± 8.89	−0.775	0.445
Sleep diary				
SOL (min.)	36.79 ± 25.94	56.51 ± 61.35	−1.146	0.261
TST (min.)	369.84 ± 47.74	393.69 ± 79.11	−1.000	0.326
WASO (min.)	42.23 ± 40.82	43.57 ± 29.53	−0.103	0.919
SE (%)	75.10 ± 12.03	75.41 ± 11.26	−0.073	0.943
Actigraphy				
SOL (min.)	12.47 ± 15.11	18.12 ± 12.78	−1.059	0.299
TST (min.)	359.97 ± 52.17	378.79 ± 49.45	−0.975	0.339
WASO (min.)	100.78 ± 26.54	112.45 ± 33.24	−1.033	0.311
SE (%)	74.52 ± 6.21	73.67 ± 5.46	0.381	0.706

Mean (±SD) scores at the baseline (before starting the CBT-I program) for both "active" (amber glasses) and "placebo" (clear glasses) groups. ISI: insomnia severity index; PSQI: pittsburgh sleep quality index; ESS: epworth sleepiness scale; SDS: sheehan disability scale; QOL: quality of life; HAS: hyperarousal scale; BDI: beck depression inventory; BAI: beck anxiety inventory; SOL: sleep onset latency; TST: total sleep time; WASO: wake after sleep onset; SE: sleep effectivity.

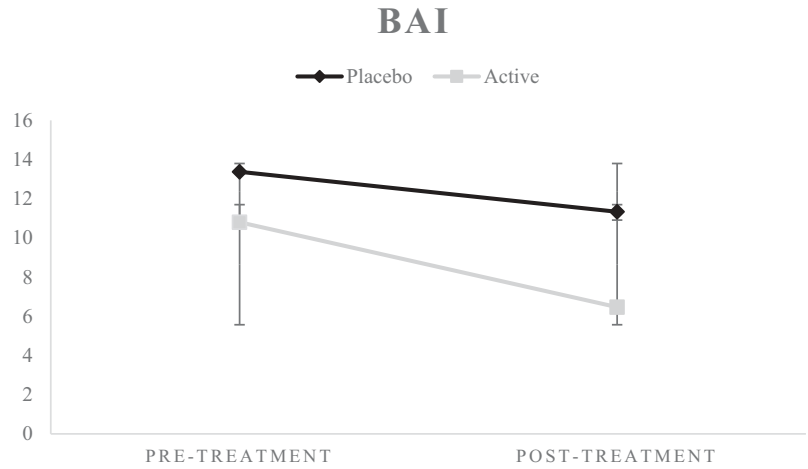

Figure 2. Pre- to post-treatment changes in BAI score in "active" and "placebo" group.
BAI: Beck Anxiety Inventory

Table 3. Comparison of questionnaire differential values between active and placebo group.

	N (Active/Placebo)	Active	Placebo	F	Sig.	Effect size
ISI	15/12	6.73 ± 4.15	5.91 ± 4.32	0.048	0.828	0.19
PSQI	15/12	4.20 ± 3.89	4.17 ± 2.89	0.258	0.617	0.01
ESS	14/12	0.57 ± 3.46	0.08 ± 2.50	1.443	0.243	0.16
SDS	15/12	8.77 ± 9.60	6.17 ± 8.80	0.073	0.789	0.28
HAS	15/12	4.66 ± 6.23	3.42 ± 9.38	0.020	0.889	0.16
BDI	15/12	5.93 ± 6.27	2.00 ± 4.65	1.694	0.207	0.71
BAI	15/12	4.33 ± 4.57	−0.91 ± 3.67	6.389	**0.019**	**1.26**

Mean (±SD) of difference in questionnaire scores pre- and post-CBT-I group program in groups of patients with "active" filtering glasses and "placebo" glasses. F values, statistical significance and effect sizes (Cohen's *d*) are provided. Positive values indicate a decrease in scores post-treatment. ISI: insomnia severity index; PSQI: pittsburgh sleep quality index; ESS: epworth sleepiness scale; SDS: sheehan disability scale; QOL: quality of life; HAS: hyperarousal scale; BDI: beck depression inventory; BAI: beck anxiety inventory.

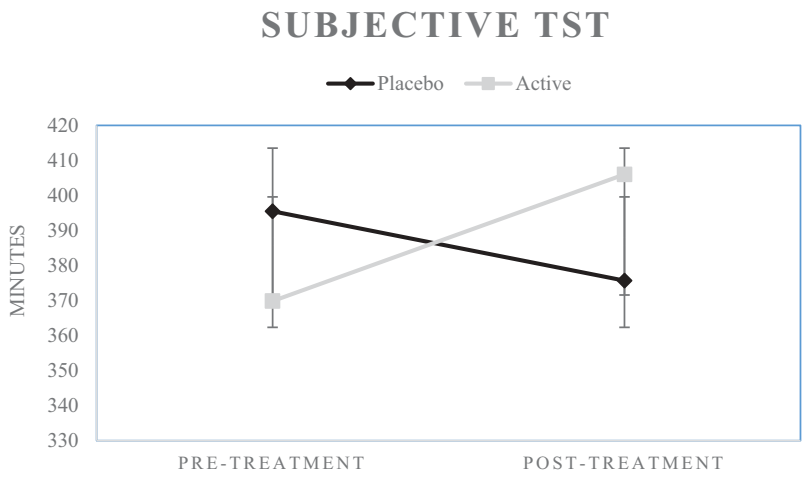

Figure 3. Pre- to post-treatment changes in subjective TST in "active" and "placebo" group.
TST: Total sleep time.

(Figure 3). Differences in all other sleep parameters were found to be insignificant and are shown in Table 4.

3.3. Effect of intervention in each group

The change between pre- and post-treatment scores for each group separately was assessed using paired-sampled t-tests. The results are to be found in Table 5.

For both active and placebo groups, a significant difference was found for the following questionnaires: ISI, PSQI and SDS, and sleep parameters: subjective WASO and subjective sleep efficiency. All these results converge to show the positive effect of both conditions on sleep quality.

Furthermore, in the active group only, a significant reduction was observed in HAS score (41.60 ± 8.40 versus 36.93 ± 10.02), (t = 2.90, p = .012, Cohen's d = 0.75), BDI-II score (15.13 ± 12.04 versus 9.20 ± 9.03), (t = 3.66, p = .003, Cohen's d = 0.95) and BAI score (10.80 ± 5.88 versus 6.47 ± 4.03), (t = 3.67, p = .003, Cohen's d = 0.95), while subjective TST was prolonged (369.14 ± 48.93 min. versus 406.02 ± 50.16 min.), (t = −2.73, p = .018. Cohen's d = −0.76). In the placebo group, a significant reduction of objective TST was observed (378.79 ± 49.46 min. versus 352.13 ± 37.17 min.), (t = 2.58, p = .024, Cohen's d = 0.72).

4. Discussion

The aim of the present study was to for the first time assess the effect of CBT-I in combination with BB glasses in insomnia patients. As expected, this combination was more effective in enhancing subjective sleep quality and reducing symptoms of anxiety, depression, and hyperarousal compared to

Table 4. Comparison of differential values of sleep parameters between the active and placebo groups.

	N (Active/Placebo)	Active	Placebo	F	Sig.	Effect size
SOL Subj. (min.)	13/14	18.39 ± 25.05	34.30 ± 61.67	1.444	0.242	0.33
SOL Obj. (min.)	15/13	3.63 ± 8.43	5.81 ± 12.34	0.968	0.335	0.21
TST Subj. (min.)	13/14	−36.88 ± 48.68	7.04 ± 47.50	8.565	**0.008**	**0.91**
TST Obj. (min.)	15/13	9.75 ± 37.32	26.66 ± 37.24	0.024	0.878	0.45
WASO Subj. (min.)	13/14	23.32 ± 38.46	12.94 ± 20.44	0.675	0.420	0.33
WASO Obj. (min.)	15/13	6.45 ± 25.21	9.99 ± 22.76	0.066	0.800	0.15
SE Subj. (%)	13/14	−15.49 ± 12.83	−10.43 ± 10.26	3.535	0.073	0.44
SE Obj. (%)	15/13	−1.21 ± 3.94	−1.27 ± 3.06	0.066	0.800	0.02
Subj. sleep quality	13/14	−0.38 ± 1.07	−0.82 ± 1.14	0.281	0.601	0.40
Morning alertness	13/14	−0.18 ± 0.80	−0.49 ± 1.12	0.015	0.905	0.32

Mean (±SD) of difference in scores of objectively (actigraphy) and subjectively rated sleep parameters pre- and post-CBT-I group program in groups of patients with "active" filtering glasses and "placebo" glasses. Negative values depict an increase in the presented variables. F values, statistical significance and effect sizes (Cohen's *d*) are provided. SOL: sleep onset latency; TST: total sleep time; WASO: wake after sleep onset; SE: sleep effectivity.

Table 5. Effect of intervention within each group.

Active (n = 15)						Placebo (n = 15)					
Sleep parameter	*Pre-treatment*	*Post-treatment*	*t*	*P-value*	*ES*	*Sleep parameter*	*Pre-treatment*	*Post-treatment*	*t*	*p Value*	*ES*
Questionnaires						Questionnaires					
ISI	17.27 ± 5.42	10.53 ± 3.36	6.29	**0.000**	**1.60**	ISI	16.83 ± 2.98	10.92 ± 3.42	4.75	**0.001**	**1.37**
PSQI	12.60 ± 4.36	8.40 ± 12.39	4.18	**0.001**	**1.08**	PSQI	13.08 ± 3.42	8.92 ± 3.20	5.00	**0.000**	**1.44**
ESS	8.71 ± 3.79	8.14 ± 4.19	0.62	0.547	0.17	ESS	5.17 ± 3.59	5.08 ± 3.53	0.12	0.910	0.03
SDS	18.97 ± 11.34	10.20 ± 6.76	3.54	**0.003**	**0.91**	SDS	14.92 ± 10.31	8.75 ± 8.11	2.43	**0.034**	**0.70**
HAS	41.60 ± 8.40	36.93 ± 10.02	2.90	**0.012**	**0.75**	HAS	35.5 ± 10.13	32.08 ± 11.28	1.26	0.233	0.36
BDI	15.13 ± 12.04	9.20 ± 9.03	3.66	**0.003**	**0.95**	BDI	11.83 ± 9.00	9.83 ± 9.38	1.49	0.164	0.43
BAI	10.80 ± 5.88	6.47 ± 4.03	3.67	**0.003**	**0.95**	BAI	10.42 ± 7.56	11.33 ± 9.99	−0.86	0.407	−0.25
Sleep diaries						Sleep diaries					
SOL (min.)	36.80 ± 27.01	18.41 ± 6.15	2.65	**0.021**	**0.73**	SOL (min.)	59.77 ± 62.30	25.48 ± 23.53	2.08	0.058	0.56
TST (min.)	369.14 ± 48.93	406.02 ± 50.16	−2.73	**0.018**	**−0.76**	TST (min.)	382.73 ± 69.27	375.69 ± 49.32	0.56	0.588	0.15
WASO (min.)	43.95 ± 41.94	20.63 ± 11.81	2.17	**0.049**	**0.61**	WASO (min.)	43.78 ± 30.64	30.83 ± 22.92	2.37	**0.034**	**0.63**
SE (%)	74.59 ± 12.63	90.09 ± 4.28	−4.35	**0.001**	**−1.21**	SE (%)	74.67 ± 11.30	85.09 ± 9.07	−3.80	**0.002**	**−1.02**
Actigraphy						Actigraphy					
SOL (min.)	12.47 ± 15.12	8.83 ± 9.83	1.67	0.117	0.43	SOL (min.)	18.12 ± 12.31	12.31 ± 11.74	1.69	0.115	0.47
TST (min.)	359.97 ± 52.18	350.22 ± 47.50	1.01	0.329	0.26	TST (min.)	378.79 ± 49.46	352.13 ± 37.17	2.58	**0.024**	**0.72**
WASO (min.)	100.78 ± 26.54	94.33 ± 29.35	0.99	0.339	0.34	WASO (min.)	112.45 ± 33.24	102.46 ± 31.60	1.58	0.140	0.44
SE (%)	74.53 ± 6.21	75.74 ± 5.67	−1.19	0.254	−0.31	SE (%)	73.68 ± 5.47	74.95 ± 5.99	−1.49	0.161	−0.41

Results of the paired-samples t-tests are presented for a group with "active" filtering glasses and "placebo" glasses. *t*-values, statistical significance and effect sizes (Cohen's *d*) are provided. ISI: insomnia severity index; PSQI: pittsburgh sleep quality index; ESS: epworth sleepiness scale; SDS: sheehan disability scale; QOL: quality of life; HAS: hyperarousal scale; BDI: beck depression inventory; BAI: beck anxiety inventory; SOL: sleep onset latency; TST: total sleep time; WASO: wake after sleep onset; SE: sleep effectivity.

CBT-I with placebo glasses. In particular, the BB glasses were associated with significantly increased subjective TST and decreased subjective SOL, unlike placebo glasses, which is in line with previous research using BB glasses in people with insomnia symptoms (Shechter et al. 2018). Moreover, BB glasses were associated with no change in objective TST which was reduced in the group with placebo glasses. The reduction of objective TST after CBT-I has been already described in the previous research as a possible consequence of sleep restriction (Kyle et al. 2014). In the present study, it seems that BB glasses could help to maintain the objective sleep duration and mitigate this side effect of sleep restriction. More studies are needed to prove this suggestion. Overall, the results are in line with studies showing a stronger impact of CBT-I on subjective sleep quality compared to objective measures (Okajima et al. 2011), further enhanced by evening blue-light filtering in the present study. Although it is beyond the scope of present work, it is important to mention that the subjective sleep parameters might be related to changes on a different level of sleep (sleep microstructure, cortical activity) (Cervena et al. 2004). Thus, more sensitive objective measures, such as polysomnography will be needed in future studies to explore changes in sleep parameters. Nevertheless, since the insomnia diagnosis is based on subjective complaints only, because of the frequent absence of objective sleep alterations, our results are of clinical relevance as in the case of a study conducted by Shechter et al. (Shechter et al. 2018).

Possible interpretations related to the usage of BB glasses may lie in the interaction between the evening blue-light spectrum exposure (usually from media devices) and its effects on sleep parameters. Studies converge to show that blue-enriched light is primarily mediated through melanopsin-based phototransduction (Bourgin and Hubbard 2016) and exposure to it in the evening hours leads to suppressed secretion of melatonin (Brainard et al. 2015), delayed sleep onset, decreased sleepiness and reduced slow-wave sleep activity (Chang et al. 2015; Gronli et al. 2016; Munch et al. 2011) resulting in lower subjectively perceived sleep quality. Using BB glasses in the evening may have mitigated the negative impact of evening blue-light exposure on melatonin and arousal levels, leading to better outcomes on studied sleep parameters. Increased subjective TST and decreased subjective SOL could be associated with an earlier dim light melatonin onset (DLMO) and an improvement in circadian regulation, although this cannot be supported by objective circadian markers in the present study. This would be in line with the results of (van der Lely et al. 2015) where an attenuated LED-induced melatonin suppression in the evening and decreased vigilant attention and subjective alertness before bedtime was found after blue-light blocking glasses intervention. Similar results were also found in another study (Heo et al. 2017), where increased evening sleepiness and shorter time to reach DLMO were found in healthy adults using phones with suppressed blue-light as compared to phones with conventional blue-light emitting screens. A suppression of melatonin levels, delayed self-selected bedtime and timing of DLMO, later SOL, lower sleepiness in the evening and lower alertness after waking up was also found in another study comparing evening usage of electronic devices and reading printed material (Chinoy et al. 2018). These studies further support our results of the decreased score in the hyperarousal scale in patients in the active glasses group, although this only reflects the subjective evaluation of one's hyperarousal. In contrast to the same study, where actigraphy-based sleep estimates showed no significant differences between conditions, we were able to detect a significant change in the objective TST in the placebo group only, while the objective TST remained unchanged in the BB glasses group. All these results suggest that wearing blue-light blocking glasses in the evening may help reduce the phase-delaying effect of light and facilitate an improvement in various subjective and objective sleep parameters, making it a worthy chronotherapeutic tool to augment CBT-I with.

Interestingly, the combination of BB glasses and CBT-I was also more effective in the improvement of daytime symptoms associated with insomnia, such as depressive and anxiety symptoms. These changes were not found in a group with placebo glasses. Light and especially short-wavelength spectrum at night has been previously associated with both disrupted mood regulation (Bedrosian and Nelson 2017) and increased cortical arousal resulting in changes in cognitive functioning

(Cajochen et al. 2011; Gaggioni et al. 2014; Smotek et al. 2019). This leads to the assumption that wearing BB glasses in the evening likely ameliorates the alerting effect of light, possibly reducing the levels of cognitive arousal, as previously confirmed by (van der Lely et al. 2015). Furthermore, blocking blue light in the evening helped normalize processing speed and working memory in patients with insomnia (Zimmerman et al. 2019).

To explain the differences in BAI and BDI-II scores, we need to look into the effects of blue-light on mood regulation in various psychiatric disorders. A study by (Yuda et al. 2017) found that blue light enhanced autonomic arousal during exposure, but not after exposure. This cannot be supported by our results, as the reduction in anxiety symptoms was only found for the somatic and subjective anxiety and not the autonomic anxiety factor. However, the comparison may not be adequate, as we used subjectively reported anxiety rather than heart rate variability used by (Yuda et al. 2017). Reduced levels of anxiety were, however, found in a study in ADHD patients with insomnia (Fargason et al. 2013), where the authors also observed a reduction of PSQI scores, less night awakenings, and higher morning refreshment after awakening. Another study has previously also confirmed the utility of "dark therapy", facilitating a quicker recovery in patients in acute mania (Henriksen et al. 2016). In a study of depressed patients with sleep-onset insomnia, the authors (Esaki et al. 2017) found no significant differences in depressive symptoms or sleep quality, even though half of the BB glasses group showed a clear improvement in sleep quality, suggesting more individualized approach may be necessary.

5. Conclusions and limitations

In this study, we provide evidence for the efficiency of BB glasses as an augmentation of CBT for insomnia patients. As compared to wearing placebo (non-filtering) glasses, patients in the active group showed a significant increase in subjective TST, no change in objective TST, decreased hyperarousal and lower scores in anxiety and depression measures. These results point to the fact that blue-light exposure in the evening may have detrimental effects on a range of biological and behavioral functions (Green et al. 2017). Despite the fact that recent literature review found lack of high-quality evidence to support using BB glasses to improve sleep quality (Lawrenson et al. 2017), we think we provided new evidence that blocking blue light in the evening may provide insomnia patients with benefits beyond the effect of the behavioral therapy itself. BB glasses, therefore, seem to be a worthy, cheap and easy-to-use, augmenting chronotherapeutic tool not only able to change subjective sleep quality, but also ameliorate mood and anxiety in patients with insomnia.

It is important to note, however, that we have not considered daytime light exposure in this study, as it may mediate or even abolish the effects of evening exposure to light (Rangtell et al. 2016). We have also not explored the potential role of chronotype nor the aspects of light hygiene prior to starting the CBT-I treatment. On the other hand, it is possible that the effects of blocking blue light in the evening may be further strengthened by additionally increasing morning and daytime light exposure, opening new venues for the future role of chronotherapy in patients with sleep disorders. This needs to be confirmed by future studies. Another limitation of the present study lies in the low number of subjects. However, given the characteristics of this clinical sample, we think this sample represents a cohort of patients that clinicians see on a daily basis. As we think that there is enough evidence today to consider the direct effect of light on sleep characteristics, the evidence for the effects of light blocking on anxiety and mood is currently lacking. We also think this study could greatly benefit from studying additional objective parameters, such as melatonin serum levels or polysomnography recordings; nevertheless, we believe this paper may be of particular interest to clinicians, as it emphasizes the need to incorporate "light hygiene" (as mentioned in Erren and Reiter (2009)) education and chronotherapeutic tools to further increase the effectiveness of CBT-I treatment.

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Author contributions

M.Š. and K.J. conceived the original idea, planned and carried out the study, led CBT-I groups, performed statistical analyses and wrote the manuscript. E.F. analyzed actigraphic data and contributed to the interpretations of the results. J. K. supervised the project and provided guidance in writing the manuscript. All authors provided critical feedback and helped shaped the research.

Disclosure statement

The authors have no conflicts of interest to declare.

Statements of Ethics

This study had prior approval from the Ethical Committee of the National Institute of Mental Health, Klecany, Czech Republic. Written informed consent was obtained from each participant after an explanation of the nature and purpose of the study.

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Kognitivně behaviorální terapie insomnie: změna spánku, nebo jeho percepce?

Cognitive behavioral therapy for insomnia: changing sleep or its perception?

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SOUHRN

Cílem studie bylo posoudit vliv kognitivně behaviorální terapie pro chronickou insomnii na subjektivní a objektivní parametry spánku. Druhým cílem bylo popsat vliv terapie na diskrepanci mezi těmito parametry (spánkovou mispercepci) u dospělých pacientů s chronickou insomnií. Do studie bylo zařazeno 16 pacientů, kteří absolvovali šestitýdenní skupinový program. Na začátku a na konci terapie pacienti vyplnili baterii dotazníků pro subjektivní hodnocení kvality spánku a denních symptomů. Po celou dobu programu pacienti vyplňovali spánkový deník pro subjektivní hodnocení spánkových parametrů. Objektivně byl spánek hodnocen pomocí aktigrafie. Terapie vedla ke snížení závažnosti symptomů insomnie a ke zvýšení celkové kvality života pacientů. Diskrepance mezi objektivní a subjektivní celkovou dobou spánku a spánkovou efektivitou se významně změnila směrem k subjektivnímu nadhodnocování těchto parametrů po terapii. Výsledky studie naznačují, že kognitivně behaviorální terapie ovlivňuje především subjektivní hodnocení závažnosti a příznaků insomnie nezávisle na změnách objektivních spánkových parametrů.

Klíčová slova: insomnie, kognitivně behaviorální terapie, objektivní a subjektivní měření spánku

SUMMARY

The aim of this study was to assess an effect of cognitive behavioural therapy of insomnia on subjective and objective sleep parameters. The second aim was to examine the effect of therapy on discrepancy between objective and subjective sleep measures (sleep misperception) in adults with chronic insomnia. Sixteen patients completed a 6 week group program. Patients filled in questionnaires assessing sleep quality, daytime symptoms and quality of life before and after the therapy, and sleep diary during the whole program. Actigraphy was used as an objective sleep measure. Therapy led to a significant decrease of insomnia severity and increased quality of life. There was a significant decrease of objective and subjective discrepancy of total sleep time and sleep efficiency after the treatment. Patients tended to significantly overestimate these parameters compared to objective measures. Our study suggests that cognitive behavioural therapy mainly affects subjective assessment of severity and of symptoms of insomnia independently on changes in objective sleep parameters.

Key words: insomnia, cognitive behavioural therapy, objective and subjective sleep measures

Úvod

Insomnie je jednou z nejčastějších poruch spánku, jejíž symptomy vykazuje přibližně 30 % dospělé populace a 6 % splňuje její diagnostická kritéria (Ohayon, 2002). Předpokládá se, že se její prevalence stále zvyšuje (Calem et al., 2012). Insomnie je definována přetrvávající nedostatečnou kvalitou či kvantitou spánku, která narušuje subjektivní pohodu nebo každodenní fungování člověka. Projevuje se potížemi s usínáním, udržením kontinuity spánku nebo předčasným ranním probuzením, přestože má pacient adekvátní příležitosti ke spánku (APA, 2013).

Až u 50 % pacientů s chronickou nespavostí se může objevit tzv. spánková mispercepce, tedy rozdíl mezi subjektivním a objektivním hodnocením spánku. Tito pacienti nadhodnocují dobu do usnutí a/nebo podhodnocují celkovou dobu spánku ve srovnání s objektivním měřením pomocí polysomnografie (PSG) (Morgenthaler et al., 2006) či aktigrafie (Tang a Harvey, 2006). Příčina spánkové mispercepce není zcela známá. Předpokládá se, že k jejímu vzniku přispívá především hyperarousal, neboli nadměrné nabuzení organismu (Tang a Harvey, 2004). Na kognitivní úrovni může mispercepce posílit přesvědčení pacienta, že je jeho spánek nedostačující, což vede k vyšší míře úzkosti a obav z nespavosti. Tyto kognitivní procesy mohou následně způsobit a udržovat hyperarousal, a tím narušit spánek na úrovni jeho makrostruktury i mikrostruktury. Dalším negativním důsledkem mispercepce je riziko rozvoje závislosti na hypnotikách či stimulanciích ve snaze léčit potíže se spánkem či ospalostí během dne (Harvey a Tang, 2012).

Za jednu z nejúčinnějších léčebných metod pro chronickou insomnii je považována kognitivně behaviorální terapie (KBT). Její dlouhodobý efekt byl opakovaně prokázán jak v individuální, tak skupinové formě (Morin et al., 2006; Koffel et al., 2015). Podle evropské směrnice by KBT měla být metodou první volby v léčbě chronické nespavosti (Riemann et al., 2017).

Přesný mechanismus účinku KBT v léčbě nespavosti však stále zůstává nejasný. Většina studií potvrzujících efektivitu

této léčby měří její efekt pomocí subjektivního hodnocení spánku pacientů s využitím spánkových deníků (van Straten et al., 2018). Pro pochopení mechanismu efektu KBT je však zapotřebí sledovat také objektivní parametry spánku. Dosud realizované studie sledující subjektivní i objektivní kvalitu spánku, naznačují významnější vliv KBT na subjektivní spánkové parametry ve srovnání s objektivními (Okajima et al., 2011).

Také není zcela objasněn vliv KBT na spánkovou mispercepci, i když studie naznačují její pozitivní efekt směrem k přesnějšímu vnímání spánkových parametrů u pacientů, kteří kvalitu spánku před terapií subjektivně podhodnocují (Lund et al., 2013; Kay et al., 2015). Dosud nebyla provedena studie zkoumající vliv KBT na spánkovou mispercepci u dospělých pacientů s insomnií bez komorbidních onemocnění.

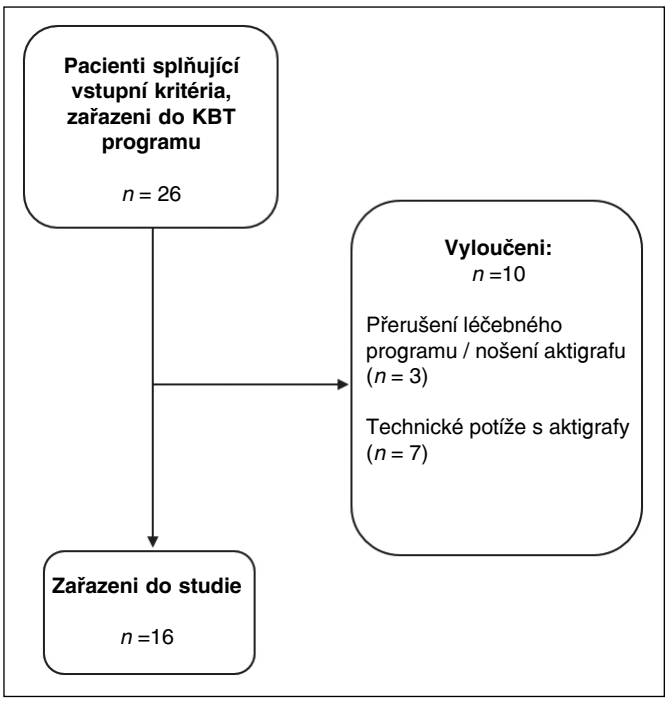
Cílem této studie je zodpovědět otázku, jaký efekt má KBT insomnie nejen na subjektivní, ale také na objektivní parametry spánku, a jaký vliv má na diskrepanci mezi těmito parametry (spánkovou mispercepci) u dospělých pacientů s insomnií bez komorbidního onemocnění. Předpokládaným výsledkem je snížení diskrepance směrem k přesnějšímu subjektivnímu hodnocení spánkových parametrů a celkové hodnocení symptomů insomnie po terapii jako méně závažné.

Materiál a metodika

Soubor osob

Nábor pacientů probíhal v ambulanci Oddělení spánkové medicíny Národního ústavu duševního zdraví (NUDZ). Kritéria zařazení do studie zahrnovala: a) naplnění diagnostických kritérií pro chronickou insomnii (potíže s usínáním a/nebo udržením spánku, nebo snížená kvalita spánku nejméně třikrát týdně po dobu nejméně jednoho měsíce, nadměrné zabývání se nekvalitním spánkem a jeho důsledky v noci i během dne, potíže se spánkem způsobují významný distres či interferují s každodenními aktivitami) (APA, 2013); b) absence závažného komorbidního psychiatrického, neurologického či somatického onemocnění; c) věk ≥ 18 let.

Studie byla před zahájením schválena Etickou komisí Národního ústavu duševního zdraví. Do studie bylo zařazeno 16 pacientů s chronickou insomnií (11 žen, průměrný věk = 41,78 let, SD = 12,63), kteří podepsali informovaný souhlas a následně absolvovali skupinovou KBT (obr. 1). Celkem 7 pacientů během KBT pravidelně užívalo medikaci ovlivňující spánek (Trittico 5, Mirtazapin 1, Quetiapin 1).



Obrázek 1: ***Grafické znázornění zařazování pacientů do studie***

Metody měření

Subjektivní měření

Na začátku a na konci terapie pacienti vyplnili baterii dotazníků Oddělení spánkové medicíny NUDZ pro subjektivní hodnocení kvality spánku a denních symptomů. Baterie obsahovala Index tíže nespavosti (Insomnia Severity Index, ISI; Bastien et al., 2001) pro hodnocení závažnosti symptomů insomnie, Epworthskou škálu spavosti (Epworth Sleepiness Sacle, ESS; Johns, 1991). Dále pacienti vyplnili Dotazník pro hodnocení kvality života, který obsahoval otázky týkající se spokojenosti se svou náladou, prací, vztahy apod. Pacienti hodnotili příslušné oblasti života na škále od 1 do 5, kdy 1 = vůbec ne, 5 = velmi často. Čím vyšší skóre v dotazníku, tím vyšší kvalita života. Jednotlivé položky dotazníku viz příloha 1.

Po celou dobu KBT pacienti vyplňovali spánkový deník pro subjektivní hodnocení spánkových parametrů. Sledovanými parametry byla průměrná délka spánkové latence (sleep onset latency, SOL), celková doba spánku (total sleep time, TST) a spánková efektivita (sleep efficacy, SE) za týden. Spánková efektivita (%) byla každý týden vypočítána podle následující rovnice: SE = (celková doba spánku / celková doba na lůžku) * 100.

Aktigrafie

Aktigrafie je jednoduchá, neinvazivní metoda, která za pomoci akcelerometru registruje pohybovou aktivitu člověka po celý den a zaznamenává tak střídání bdění a spánku. Jedná se o malé zařízení, které je podobné náramkovým hodinkám. Aktigraf má výhodu v tom, že měří spánkové návyky v běžném prostředí člověka. Několik studií již prokázalo jeho senzitivitu a klinické využití v objektivním měření odpovědi na léčbu u pacientů s chronickou insomnií (Vallieres a Morin, 2003). Pro tuto studii byly použity aktigrafy MotionWatch 8 (CamNtech Ltd, UK). Pacienti byli požádáni, aby stiskli tlačítko aktigrafu ve chvíli, kdy večer uléhali do postele a když ráno vstali. Tím se v záznamu označila doba, kterou pacienti strávili na lůžku, což usnadnilo hodnocení spánku a bdění při zpracovávání aktigrafických záznamů pomocí softwaru MotionWare.

Sledovanými parametry byly, stejně jako u spánkových deníků, průměrná SOL, TST a SE. Díky subjektivním i objektivním parametrům spánku bylo možné vypočítat index mispercepce (Misperception Index, MI) pro kvantifikaci spánkové mispercepce TST a SE. Příklad výpočtu MI TST = (objektivní celková doba spánku – subjektivní celková doba spánku) / objektivní celková doba spánku. Pozitivní hodnota MI reflektuje tendenci k subjektivnímu podhodnocení celkové doby spánku, negativní hodnota tendenci k jejímu nadhodnocení, hodnota 0 reflektuje přesný subjektivní odhad ve srovnání s objektivním měřením. MI je

Tabulka 1: ***Struktura jednotlivých KBT sezení***

Sezení 1	Úvodní informace o KBT, vzniku a udržování insomnie, spánkový deník
Sezení 2	Edukace o cirkadiánní a homeostatické regulaci spánku, nastavení cílů terapie, nastavení spánkové restrikce
Sezení 3	Edukace o architektuře spánku, hyperarousalu, relaxaci, pravidlo 20 minut, krizový plán pro případ prodloužené spánkové latence
Sezení 4	Edukace o bludném kruhu insomnie
Sezení 5	ANM, kognitivní restrukturalizace, záznam ANM
Sezení 6	Kognitivní restrukturalizace, prevence relapsu, individualizovaná doporučení

ANM: automatické negativní myšlenky

považován za spolehlivé měřítko mispercepce (Manconi et al., 2010). Pro měření diskrepance spánkové latence byl vypočítán rozdíl mezi subjektivní a objektivní dobou spánkové latence (subjektivní SOL – objektivní SOL) (Herbert et al., 2017). Negativní hodnoty značí subjektivní podhodnocování doby spánkové latence ve srovnání s objektivním záznamem, pozitivní hodnoty značí subjektivní nadhodnocování doby spánkové latence.

Kognitivně behaviorální terapie

Pacienti absolvovali skupinovou KBT v celkové délce šesti týdnů. Sezení probíhala jednou týdně po dobu dvou hodin v prostorách denního stacionáře NUDZ. Struktura vycházela z doporučeného postupu klinického manuálu pro léčbu insomnie (Morin a Espie, 2003). Plán sezení je znázorněn v tab.1. Každé sezení začínalo reflexí kvality spánku za uplynulý týden a zpětnou vazbou terapeuta. Následně byla pacientům poskytnuta psychoedukace o konkrétním tématu, např. o regulaci spánku, a doporučení na další týden. Spánková restrikce byla poprvé aplikována na druhém sezení na základě výpočtu průměrných spánkových parametrů za první týden terapie. Podle průměrné doby spánku za uplynulý týden byla doporučena celková doba na lůžku na další týden (minimálně 5 hodin). Spánkový režim byl následně upravován na začátku každého sezení podle aktuálního hodnocení spánku za uplynulý týden. Pokud spánková efektivita dosáhla nejméně 85 %, celková doba na lůžku byla na další týden prodloužena o 15 minut. Pokud byla nižší, nastavení restrikce zůstalo stejné. Na třetím sezení byli pacienti poučeni o tzv. pravidle 20 minut. Podle tohoto doporučení měli opustit lůžko, pokud podle svého subjektivního odhadu neusnuli do 20 minut od ulehnutí. Každý pacient měl připravený plán příjemných aktivit, které vykonával v jiné místnosti, dokud necítil znovu ospalost.

Analýza

Statistická analýza byla provedena v programu IBM SPSS verze 23. Normalita rozložení dat byla ověřena pomocí Shpario-Wilkova testu. Následně byl použit párový t-test pro závislé výběry pro zhodnocení rozdílu před a po terapii, a byla vypočtena velikost efektu (Cohenovo d). Hladina významnosti byla stanovena na hodnotě 0,05. Pro analýzy rozdílu mezi jednotlivými položkami Dotazníku kvality života byl použit Wilcoxonův test vzhledem k nenormálnímu rozložení dat.

Výsledky

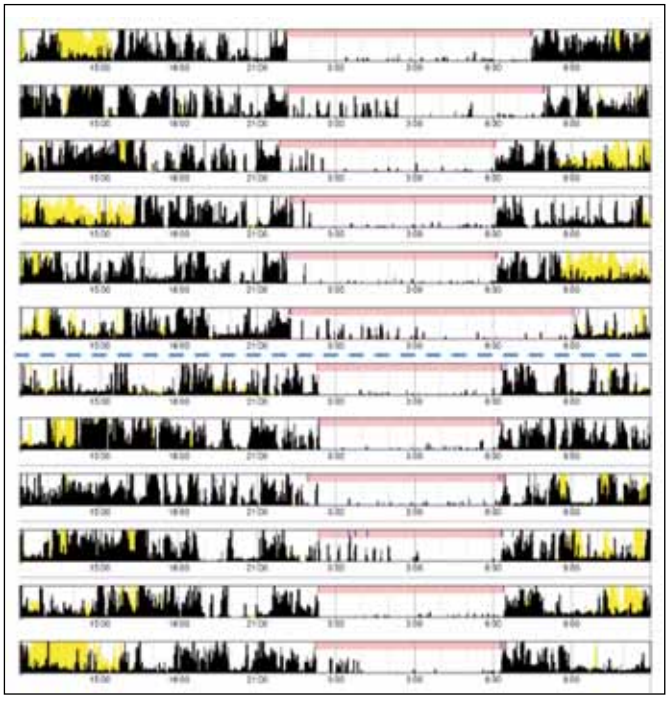
Sebeposuzovací škály

Absolvování KBT vedlo k signifikantnímu poklesu celkového skóru Indexu tíže nespavosti z průměrného skóru 18 (SD = 3,5) před terapií na průměrný skór 9 (SD = 3,9) po terapii, p < 0,000, d = 2,21. Po terapii nedošlo ke snížení celkového skóru na škále ESS (M = 7, SD = 4,21 vs. M = 6, SD = 3,69), p = 0,557, d = 0,15. Nicméně významně se zvýšil skór Dotazníku kvality života z 50,69 (SD = 7,6) na 58,94 (SD = 8,1), p < 0,000, d = -1,16. K významné změně došlo v položkách hodnotících Společenský život (p = 0,051), Schopnost uplatnit se v denním životě (p = 0,013), Spokojenost se sexuálním životem (p = 0,018), Způsob života a bydlení (p = 0,008), Možnost pohybu bez pocitů nejistoty, závratí nebo pocitů na omdlení (p = 0,010) a Celkovou spokojenost s životem (p = 0,042).

Subjektivní a objektivní parametry spánku

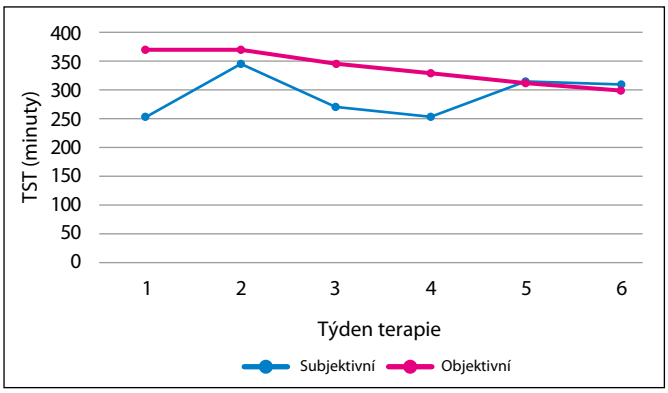
Po terapii nedošlo k signifikantní změně v subjektivní době spánkové latence (M = 22 min, SD = 28,05 vs. M = 23 min, SD = 8,69), p = 0,078, d = 0,47. Nezměnila se ani subjektivní celková doba spánku (M = 342 min, SD = 0,94 vs. M = 354 min, SD = 0,84), p = 0,262, d = -0,29. Naopak subjektivní spánková efektivita se po terapii signifikantně zvýšila z průměrných 74,25 (SD = 10,47) na 83,81 (SD = 7,09) procent, p = 0,002, d = -0,94.

U objektivních spánkových parametrů došlo ke zkrácení celkové doby spánku (M = 348 min, SD = 0,73 vs. M = 318 min, SD = 0,70). Tento rozdíl dosahoval hladiny signifikance,



Obrázek 2: ***Příklad aktigrafického záznamu (aktigram) prvních dvou týdnů terapie, které odděluje modrá přerušovaná linka.***

První týden reflektuje spánek a denní aktivitu pacienta před terapií, v druhém týdnu byla již aplikována spánková restrikce. Černá barva v grafu znázorňuje pohybovou aktivitu, absence černé barvy reflektuje epizodu spánku, růžová barva označuje celkovou dobu na lůžku, žlutá barva znázorňuje vystavení participanta dennímu či umělému světlu.



Graf 1: ***Efekt KBT (kognitivně behaviorální terapie) na subjektivní a objektivní TST (total sleep time; celková doba spánku) během terapie u jednoho z pacientů***

Znázorněny jsou průměrné hodnoty z každého týdne terapie.

p = 0,054, d = 0,52. Po terapii došlo také ke zkrácení objektivní doby spánkové latence (M = 12 min, SD = 8,08 vs. M = 8 min, SD = 6,27), tento rozdíl byl signifikantní, p < 0,000, d = 111. Objektivní efektivita spánku se významně nezměnila (M = 74,46, SD = 5,12 vs. M = 74,73, SD = 5,22), p = 0,737, d = -0,09. Graf 1 znázorňuje změnu objektivní a subjektivní TST během 6 týdnů KBT u jednoho z pacientů. Příklad aktigrafického záznamu jednoho z pacientů je uveden na obr. 2.

Subjektivní a objektivní diskrepance spánku

Po KBT došlo k signifikantní změně v hodnotě mispercepce celkové doby spánku směrem k jejímu subjektivnímu nadhodnocování (M = 0,01, SD = 0,18 vs. M = -0,13, SD = 0,16), p = 0,001, d = 1,09. Vizualizace změny u každého participanta je znázorněna v grafu 2. Také došlo ke změně mispercepce spánkové efektivity z průměrné hodnoty -0,002 (SD = 0,18) před terapií na -0,123 (SD = 0,12) po terapii, p = 0,003, d = 0,89 (viz graf 3). Po terapii nedošlo k signifikantní změně diskrepance mezi objektivní a subjektivní dobou spánkové latence (M = 24,28, SD = 31,89 vs. M = 14,86, SD = 11,81), p = 0,228, d = 0,32.

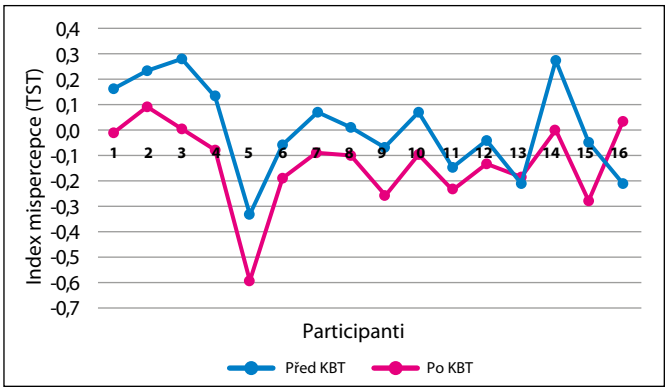
Diskuse

Cílem studie bylo popsat vliv skupinové KBT na objektivní a subjektivní hodnocení spánku a spánkovou mispercepci u dospělých pacientů s insomnií bez závažného komorbidního onemocnění. Podle výsledků analýz vedla terapie ke snížení závažnosti symptomů insomnie (ISI) a ke zvýšení celkové kvality života pacientů. Tyto výsledky jsou v souladu s předchozími studiemi, které hodnotily efekt léčby pomocí ISI (Cervena et al., 2004) a dotazníků kvality života (Espie et al., 2018). Konkrétně došlo k významnému zvýšení spokojenosti se společenským a sexuálním životem, způsobem života a bydlení, schopností uplatnit se v denním životě, možnosti pohybu bez pocitů nejistoty, závratí nebo pocitů na omdlení, a celkové spokojenosti.

KBT nevedla ke změně celkového skóru na škále denní spavosti (ESS). Velikost skóru však ani před terapií nenaznačovala významnou denní spavost (Johns, 1991), což je v souladu s ostatními studiemi. I přes narušený spánek nejsou u pacientů s insomnií popisovány známky zvýšené denní spavosti. Jedním z možných vysvětlení je právě zvýšené nabuzení (hyperarousal), které bývá u těchto pacientů přítomné 24 hodin denně, tedy nejen v noci, ale i přes den, a vede tak k vyšší míře bdělosti (Riemann et al., 2010).

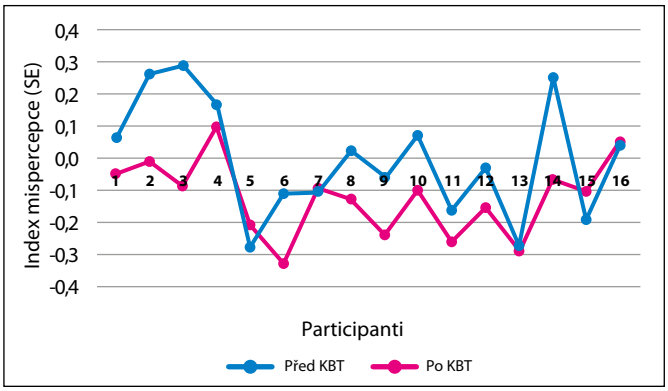
K redukci subjektivně hodnocené závažnosti insomnie u pacientů došlo i přesto, že ze subjektivních spánkových parametrů se změnila pouze spánková efektivita, která se po terapii zvýšila. Subjektivní celková doba spánku se signifikantně nezměnila. Přesto údaje z deníků naznačují její prodloužení (průměrně o 12 minut). Subjektivní doba spánkové latence zůstala stejná před i po terapii, přičemž ani před terapií u pacientů nevykazovala významných hodnot (průměrně 22 minut). Tyto výsledky jsou v souladu s předchozími studiemi, které nepopisují změnu subjektivní celkové doby spánku (Edinger et al., 2007). S ohledem na mechanismus spánkové restrikce může být tento výstup považován za pozitivní výsledek terapie. Oproti počátečnímu měření se subjektivní délka spánku významně nezkrátila i přesto, že se zkracovala doba na lůžku.

Co se týče objektivních parametrů, spánková efektivita se významně nezměnila. Naopak objektivní celková doba spánku a doba spánkové latence se po KBT zkrátily. Na



Graf 2: ***Efekt KBT na MI TST u každého participanta***

TST: celková doba spánku; KBT: kognitivně behaviorální terapie; MI: index mispercepce. MI = 0: subjektivní odhad odpovídá objektivnímu měření; MI > 0: subjektivní podhodnocení TST ve srovnání s objektivním měřením; MI < 0: subjektivní nadhodnocení TST ve srovnání s objektivním měřením.



Graf 3: ***Efekt KBT na MI SE u každého participanta***

SE: spánková efektivita; KBT: kognitivně behaviorální terapie; MI: index mispercepce. MI = 0: subjektivní odhad odpovídá objektivnímu měření; MI > 0: subjektivní podhodnocení SE ve srovnání s objektivním měřením; MI < 0: subjektivní nadhodnocení SE ve srovnání s objektivním měřením.

zkrácení celkové doby spánku mohla mít do značné míry vliv nastavovaná spánková restrikce. Tyto výsledky odpovídají závěrům předchozích studií, které potvrzují minimální efekt KBT na makrostrukturu spánku (Edinger et al., 2007). Je však zapotřebí zmínit, že vliv KBT se může objevit i v jiných objektivních parametrech spánku na úrovni jeho mikrostruktury (zastoupení spánkových stadií, kortikální aktivita během spánku), jak popisují např. Cervena et al. (2004). Otázkou zůstává, zda je významnějším korelátem subjektivní kvality spánku jeho makrostruktura či mikrostruktura, a jak se do subjektivního hodnocení spánku promítají individuální rozdíly. Výsledky studií může také do jisté míry ovlivňovat heterogenita insomnie jako takové. Pacienti s insomnií mohou vykazovat objektivně krátkou, ale i normální celkovou dobu spánku. Podle toho se pak může lišit jejich odpověď na KBT (Bathgate et al., 2017).

KBT vedla k významné změně diskrepance mezi objektivní a subjektivní celkovou dobou spánku a spánkovou efektivitou směrem k subjektivnímu nadhodnocování těchto parametrů. Podle měření před terapií ne všichni pacienti v naší skupině podhodnocovali celkovou dobu spánku (hodnota MI nebyla u všech pozitivní). Nicméně z grafu 2 je patrné, že u pacientů podhodnocujících na začátku terapie celkovou dobu spánku se po terapii tato diskrepance zmírnila, a hodnota MI se posunula směrem k přesnějšímu vnímání délky spánku, což je v souladu se studií autorů Lund et al. (2013). Naopak u pacientů, kteří na začátku terapie neměli vyšší míru diskrepance směrem k podhodnocování celkové doby spánku, se po terapii velikost MI přesunula do minusových hodnot – tedy k subjektivnímu nadhodnocování celkové doby spánku. Toto je zajímavé zjištění vzhledem k předpokladům předchozích studií, že diskrepance by se měla po absolvování KBT zmírnit, a percepce spánku by měla být přesnější. Dosud však žádná studie nepopisuje vliv KBT na diskrepanci v opačném směru, tedy na tzv. pozitivní mispercepci (Trajanovic et al., 2007). Podobný výsledek pak vidíme u mispercepce spánkové efektivity, která se zmírnila u pacientů s pozitivní hodnotou MI před terapií, a naopak se ještě více zvýšila u pacientů s přesnou percepcí či nadhodnocováním SE před terapií. Podle našich výsledků se zdá, že KBT vede k subjektivnímu nadhodnocování celkové doby spánku a spánkové efektivity u pacientů, kteří už před terapií vykazují tendenci k nadhodnocování celkové doby spánku, či její přesnou percepci.

Jednou z limitací této studie je nízký počet zařazených osob. I přesto bylo možné detekovat významné změny sledovaných proměnných a naše výsledky jsou v souladu s předchozími studiemi. Za druhé, absence kontrolní skupiny neumožňuje srovnat míru diskrepance a narušení spánku pacientů se zdravými osobami, či srovnat efekt KBT s jinou kontrolní terapií. Za třetí, pacienti se lišili v množství a typu léků užívaných během terapie. Pro realizaci studie však nebylo možné zařadit dostatečný počet pacientů bez medikace vzhledem k tomu, že metodou první volby léčby insomnie v ČR je stále farmakoterapie.

Závěr

Skupinová KBT vedla k významnému snížení závažnosti příznaků insomnie a k signifikantnímu zvýšení celkové kvality života pacientů i přes to, že po terapii nedošlo k prodloužení objektivní ani subjektivní celkové doby spánku. Po terapii došlo ke změně spánkové mispercepce směrem k subjektivnímu nadhodnocování celkové doby spánku a spánkové efektivity. Podle vizuální analýzy k této změně mispercepce došlo nejen u pacientů, kteří podhodnocují délku svého spánku, ale i u těch, kteří ji vnímají poměrně přesně, či ji dokonce nadhodnocují před začátkem terapie. Výsledky studie naznačují, že KBT ovlivňuje především kvalitu života pacientů a jejich subjektivní hodnocení závažnosti insomnie nezávisle na změnách objektivních spánkových parametrů.

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Příloha I: ***Dotazník Kvality života***

V otázce zakroužkujte číslo odpovídající vašemu pocitu.

1 = vůbec ne / nikdy
2 = zřídka
3 = někdy
4 = často nebo většinu času
5 = velmi často / stále

Když vezmete v úvahu všechny okolnosti, jak jste byl/a během minulého týdne spokojeny/á:

• se svou náladou?	1	2	3	4	5
• se svou prací?	1	2	3	4	5
• se zvládáním domácnosti?	1	2	3	4	5
• se svým společenským životem?	1	2	3	4	5
• se vztahy ve své rodině?	1	2	3	4	5
• s využitím svého volného času?	1	2	3	4	5
• se svou schopností uplatnit se v dennim životě?	1	2	3	4	5
• se svým sexuálnim životem (touha, zájem, výkon)?	1	2	3	4	5
• se svou finanční situaci?	1	2	3	4	5
• se způsobem života nebo s bydlením?	1	2	3	4	5
• s možností pohybu bez pocitů nejistoty, závrati nebo pocitů na omdlení?	1	2	3	4	5
• se schopností pracovat nebo se věnovat koníčkům podle svých představ?	1	2	3	4	5
• cítil/a jste se během minulého týdne celkově dobře?	1	2	3	4	5
• se svými léky? (Jestliže žádné neužíváte, body přeškrtněte.)	1	2	3	4	5
• Jak byste hodnotil/a celkovou spokojenost se životem během posledního týdne?	1	2	3	4	5

Sečtěte zakroužkované body: .....