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Original article

Efficacy of Email-delivered Versus Face-to-face Group Cognitive Behavioral Therapy for Insomnia in Youths: A Randomized Controlled Trial

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A B S T R A C T

Purpose: The purpose of the study was to compare the efficacy of group-based therapy (GT) and email-delivered self-help (ESH) cognitive behavioral therapy for insomnia (CBT-I) with the wait-list (WL) control group in youths.
Methods: The study involved an assessor-blind, parallel group randomized controlled trial in youths meeting the diagnostic criteria for insomnia disorder. Participants were randomized to one of the three groups (8-week GT, 8-week ESH, or WL). Participants in all three groups were assessed at baseline and after treatment (week 9 for the WL group). The two treatment groups were additionally assessed at one month and six months after the intervention. Treatment effects were examined using linear mixed models.
Results: A total of 135 youths (mean age: 20.0 ± 2.5 years, female: 67.4%) were recruited. After treatment, both active treatment groups showed significant improvements in insomnia symptoms (GT vs. WL: Cohen's $d = -1.03$, ESH vs. WL: $d = -.63$), less presleep arousal ($d = -.52$ to -1.47), less sleep-related dysfunctional belief ($d = -.88$ to -1.78), better sleep hygiene practice ($d = -.79$ to $-.84$), and improved daytime functioning ($d = -.56$ to $-.96$) compared with the WL group. In addition, GT outperformed ESH in improving maladaptive sleep-related beliefs and mood symptoms at post-treatment and 6-month follow-up. A reduction of suicidality with moderate effect size favoring GT emerged at 6-month follow-up.

IMPLICATIONS AND CONTRIBUTION

The findings of the present study support the effectiveness of both group-based face-to-face and email-delivered self-help cognitive behavioral therapy for insomnia (CBT-I) in improving sleep-related outcomes in the youth population. The group-based CBT-I showed additional benefits of improving some aspects of sleep as measured by sleep diary and mood symptoms.

Conflicts of interest: The authors have no conflicts of interest to disclose.
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Discussion: Our findings suggested that both group-based and email-delivered CBT-I were effective in treating youth insomnia, but group-based CBT-I showed superior effects on reducing maladaptive beliefs and mood symptoms.

Insomnia is a prevalent sleep problem affecting up to 37% of young people, with a surge in incidence in late adolescence [1,2]. Collective evidence has suggested that insomnia is associated with a wide range of repercussions including poor daytime functioning, cognitive impairments, physical and psychiatric comorbidities, and an increased risk for suicidality, which underscore the need for early intervention for insomnia in this vulnerable population [2–5].

Cognitive behavioral therapy for insomnia (CBT-I) is recommended as the first-line treatment for insomnia in adults [6] and is traditionally delivered on an individual basis. Increasing studies showed that group-based CBT-I had comparable positive effects with the individual format in the adult population [7]. However, the data on the efficacy of different modalities of CBT-I in adolescents remained limited. In addition, help-seeking behavior is very uncommon in young people, with only 10% having had sought help for their sleep problems [8]. Self-help approach may be the potential solution to address the low accessibility to CBT-I. In particular, internet-delivered self-help CBT-I has been shown in different studies to have comparable therapeutic effects with face-to-face modality, albeit with an apparently large range of effect sizes (from 0.21 to 1.09) [9]. However, self-help CBT-I has been understudied in the youth population [10,11]. Moreover, youths tend to prefer self-help intervention rather than face-to-face treatment as it may minimize the stigma by allowing anonymity [12].

The present study aimed to compare the efficacy of face-to-face group-based therapy (GT) and email-delivered self-help (ESH) therapy, as compared with the wait-list (WL) control group, in treating insomnia in youths. We hypothesized that (1) youths who received CBT-I treatment either in a group format or by emails would have improved insomnia symptoms, better sleep hygiene, and less dysfunctional beliefs about sleep after the intervention as compared with the WL controls; (2) both treatment groups would have improved mental health, daytime functioning, and general well-being after treatment, as compared with the WL controls; and (3) both treatment groups would show comparable treatment effects on improving sleep, mood, daytime functioning, and general well-being after the intervention and throughout the follow-up periods.

Methods

Study design

This study was an assessor-blind, 3-arm (GT, ESH, and WL) parallel group randomized controlled trial. Eligible participants were randomized to one of the three groups using block randomization with equal allocation to each group. Eligible participants were randomly assigned to one of the three groups by an independent research staff member who was not involved in the assessments and interventions, as per a computerized generated randomization sequence. Assessors were blinded to the group allocation. Participants in the two treatment groups were assessed after treatment, one month and six months after the intervention, whereas for the WL participants, they were reassessed at week 9 (equivalent to the post-treatment assessment of the two treatment groups) after baseline assessment and were subsequently provided with CBT-I treatment based on their preference (Figure 1).

Participants

Participant recruitment was conducted in the local secondary schools and universities between October 2017 and May 2019 via a variety of sources (e.g., school-based mass mailing, social media, leaflets and flyers disseminated in schools, and telephone invitations made to the potential eligible participants as identified from our previous community-based studies) [5,13,14]. All the participants underwent face-to-face structured screening interview conducted by the clinicians who have received specialized training in sleep medicine (including one qualified clinical psychologist and two master-level clinical psychology trainees) to ascertain their eligibility. The inclusion criteria are: (1) Chinese aged 12–24 years old and (2) a diagnosis of insomnia disorder as per the criteria of DSM-5. Information about the symptoms, frequency, and duration of insomnia as well as the associated daytime functional impairments and distress was specifically collected during the clinical interview to ascertain participants' insomnia diagnosis. To standardize the interviews, we adopted the items from the Insomnia Module in the Diagnostic Interview for Sleep Disorder (DISP) to elicit the participants' responses when assessing insomnia. Regarding the age range selection, according to the World Health Organization, "young people" covers the age range from 10 to 24 years old. In Hong Kong, most of the students in the secondary school are aged 12 or above. In this study, our target participants were mainly the students from the local secondary schools and colleges, who were usually aged from 12 to 24 years old. Taken all these considerations together, we chose the 12–24 years age group to cover a wider developmental span of young people. The exclusion criteria are: (1) a current or past history of substance abuse or dependence, bipolar disorders, schizophrenia spectrum disorders, neurodevelopmental disorders, organic disorders, or intellectual disabilities, (2) a prominent medical condition, or concurrent, regular use of medications that are known to interfere with sleep continuity and quality, (3) a clinically diagnosed sleep disorder other than insomnia disorder (e.g., obstructive sleep apnea, restless leg syndrome) as ascertained by the DISP [15], (4) a clinically significant risk for suicidality (moderate or high risk as assessed by the Suicidality Module of the Mini International Neuropsychiatric Interview) [16], (5) enrolled in any other clinical trial of investigational products within one month before joining the study, (6) initiation of or change in antidepressant medication within past two months, (7) having been or is currently receiving any structured psychotherapy, (8) with hearing or speech deficit, and (9) shift worker.

All the participants provided their informed consent. For those aged below 18, parental consent was further obtained.

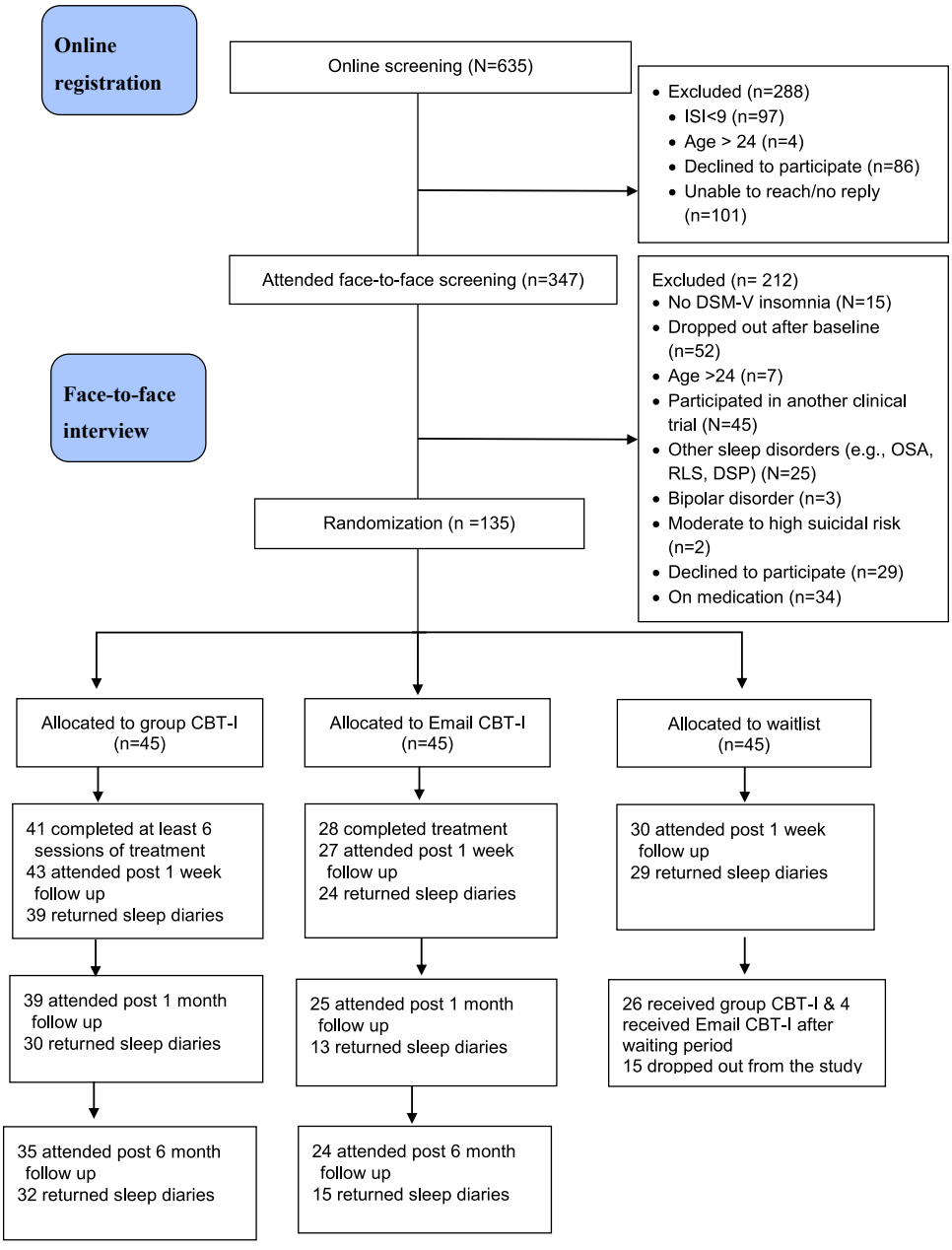

Figure 1. The consort diagram of subject recruitment.

Participants received HKD$200–400 depending on the number of their completed visits for assessments. The study was approved by the University Research Ethics Committee and registered with the clinical trial registry, US National Institutes of Health (NCT03522701).

Intervention

The GT and ESH CBT-I had comparable treatment content with the same dose (eight weekly sessions) (Table A1). The treatment content was structured and developed based on the well-established CBT elements for treating insomnia. A previously established email-delivered sleep intervention that was initially designed to improve sleep in university students ("REFRESH") was adopted for the ESH group [17]. In addition, the program was modified to include a circadian-related component. Relevant psychoeducation and strategies related to circadian issues, such as morning light exposure, were introduced in the treatment program. In addition, age-appropriate examples were provided in the group sessions, and the therapists led the group discussions tailored to the participants' developmental context, whereas for the email CBT-I materials, vignette examples specific to the student populations were incorporated. In the GT group, treatment sessions were delivered by the experienced therapists trained in sleep medicine (SX Li, SP Lam, and NY Chan). Each session

Table 1
Demographic and clinical characteristics of the study participants

	GT (N = 45)	ESH (N = 45)	WT (N = 45)	*p* value
Age, years, mean (SD)	19.4 (2.3)	20.9 (2.5)	19.7 (2.6)	**.01**
Sex, female, n (%)	30 (66.7)	32 (71.1)	29 (64.4)	.79
Education				
Master, n (%)	0 (0)	4 (9.1)	3 (6.7)	**.03**
Undergraduate, n (%)	31 (68.9)	37 (81.8)	29 (64.4)	
Secondary, n (%)	14 (31.1)	4 (9.1)	13 (28.9)	
Insomnia duration, years, mean (SD)	2.7 (2.2)	3.2 (2.8)	4.1 (3.9)	.11
Comorbid depression, n (%)	19 (42.2)	12 (26.7)	17 (37.8)	.28

ESH = email-delivered self-help; GT = group-based therapy; SD = standard deviation; WL = wait-list.
Bold values indicate statistical significant at $p < .05$.

lasted for 90 minutes, and each group consisted of five to eight participants. The face-to-face group sessions were attended by the youth participants only (without parental attendance) and were conducted in two universities (The University of Hong Kong and The Chinese University of Hong Kong).

In the ESH group, participants received a weekly email attached with treatment materials for eight consecutive weeks. New session materials would be sent on receiving participants' sleep diary. Reminders of completing the sleep diary were sent before the start of each session. Participants were considered as dropping out from the treatment if they were unable to return the sleep diary two weeks after receiving the session materials or provided no response after three reminders.

Measurements

Sleep-related measures. The severity of insomnia symptoms was measured by using the Insomnia Severity Index (ISI), a 7-item inventory designed to assess the nature, severity, and impact of insomnia in both adolescents and adults [18]. Sleep quality was measured by the Pittsburgh Sleep Quality Index [19], a 19-item questionnaire used to evaluate several dimensions of sleep over a one-month period. Participants were also asked to fill in the one-week consensus sleep diary-core [20] at all assessment time points. Sleep parameters, including time in bed, total sleep time, sleep onset latency, wake after sleep onset, and sleep efficiency, were calculated from the diary data.

Clinical Global Impression Scale—Global Improvement and Severity of illness (CGI-S and CGI-I) was administered by the clinician to assess participants' overall severity of the illness and clinical changes after treatment [21].

The Dysfunctional Beliefs and Attitudes About Sleep Scale (DBAS) [22,23] is a 16-item questionnaire used to measure faulty sleep-related beliefs and cognitions. The average score was computed, with a higher score representing a greater level of dysfunctional beliefs and cognitions toward sleep.

Sleep habits were measured by using the Sleep Hygiene Practice Scale [24]. It is a 30-item inventory designed to measure maladaptive sleep hygiene in daily practice and consists of the following four subscales: (1) regularity of sleep schedule, (2) behavioral arousal, (3) eating/drinking near bedtime, and (4) sleep environment. Higher scores indicated more maladaptive sleep hygiene practices. The scale demonstrated acceptable internal consistency in the current sample (Cronbach's $\alpha = 0.76$ in secondary school students; Cronbach's $\alpha = 0.86$ in college students).

The Presleep Arousal Scale is a 16-item self-reported inventory developed to measure both cognitive and somatic manifestations of arousal near bedtime [25], with higher scores indicating greater arousal. It showed good internal consistency in the current sample (Cronbach's $\alpha = 0.85$ in secondary school students; Cronbach's $\alpha = 0.87$ in college students).

Mood-related measures

Assessor-rated measurement. The Hamilton Rating Scale for Depression (HRSD) is a 17-item clinician-administered instrument designed to assess depressive symptomatology [26]. All the items were added up, with higher scores indicating greater severity. The clinical assessments were conducted by the research clinicians and clinical psychologist trainees. The inter-rater intraclass correlation coefficient was 0.97 (95% confidence interval: 0.95–0.99), indicating excellent inter-rater reliability.

Self-rated measurements. The Hospital Anxiety and Depression Scale was used as a self-report measure of the severity of depressive and anxiety symptoms and has been validated in both adolescent and adult populations [27]. The Depressive Symptom Inventory—Suicidality Subscale is a 4-item inventory used to assess the extent to which an individual is experiencing suicidal thought(s) [28].

Daytime functioning and general well-being

Daytime sleepiness and fatigue were measured by using the Pediatric Daytime Sleepiness Scale (PDSS) and Multidimensional Fatigue Inventory (MFI) [29,30], respectively. The MFI has been used in both adolescents and young adults in previous research. It consists of five subscales including general fatigue, physical fatigue, mental fatigue, reduced motivation, and reduced activities. Higher scores of the MFI and PDSS indicated higher levels of fatigue and sleepiness, respectively [31]. Kidscreen-27 health-related quality of life is a self-report questionnaire that consists of 27 items to assess five dimensions of quality of life, including physical well-being, psychological well-being, parent relations and autonomy, peer relationship, and school environment [32,33]. The total score of the items was computed based on the Rasch model for each dimension and was transformed into values with a mean of 50 and a standard deviation of 10. Higher scores indicated better quality of life and well-being [32,33]. Both PDSS and Kidscreen-27 demonstrated acceptable internal consistency in the current sample (PDSS: Cronbach's $\alpha = 0.61$ in secondary school students; Cronbach's $\alpha = 0.63$ in college students; Kidscreen-27: Cronbach's $\alpha = 0.80$ in secondary school students; Cronbach's $\alpha = 0.75$ in college students).

Statistical analysis

Demographic characteristics and baseline data were compared between groups using one-way analysis of variance and chi-square tests wherever applicable. The primary outcome was the ISI score. The secondary outcomes included clinician-rated and self-reported mood symptoms, sleep-related measures, daytime functioning, and well-being. Remission of insomnia was defined as the ISI <8 at follow-up assessments,

Table 2
Comparisons of insomnia, sleep quality, and sleep diary measures at all time points across the three groups

Variable	Assessment timepoint	GT	ESH	WL	Time* group interaction		Effect size *(d)*		Time* group interaction		Effect size *(d)*
					GT, ESH versus WL[a]		GT versus WL	ESH versus WL	GT versus ESH[b]		GT versus ESH
					F	p	*d*	*d*	F	p	*d*
Self-reported											
Insomnia (ISI)	Baseline	16.1 (4.2)	15.4 (4.4)	16.0 (4.2)							
	Post-treatment	9.0 (4.5)	10.0 (5.3)	13.7 (5.1)	**7.5**	**.001**	−1.03**	−.63*			−.38
	P1M	8.0 (5.6)	9.0 (5.1)								−.36
	P6M	7.5 (5.2)	8.2 (5.5)						1.0	.41	−.40
Sleep quality (PSQI)	Baseline	10.8 (2.6)	10.3 (2.4)	10.8 (2.6)							
	Post-treatment	6.8 (2.5)	7.5 (2.8)	9.6 (3.4)	**6.8**	**.002**	−1.04**	−.60			−.45
	P1M	6.1 (3.0)	7.5 (3.0)								−.53
	P6M	5.8 (3.4)	6.6 (3.4)						1.1	.35	−.29
Clinician-rated											
Overall improvement (CGI-S)	Baseline	3.5 (0.9)	3.3 (1.1)	3.2 (1.1)							
	Post-treatment	1.7 (1.1)	2.3 (1.4)	3.1 (1.2)	**10.7**	**<.001**	−1.54**	−.76*			−.75*
	P1M	1.8 (1.1)	1.9 (1.2)								−.17
	P6M	1.7 (0.9)	2.4 (1.4)						**2.8**	**.046**	−.75*
Sleep diary measures											
Total sleep time hh:mm	Baseline	6:44 (1:32)	6:28 (1:01)	6:42 (1:09)							
	Post-treatment	7:07 (0:43)	6:52 (0:53)	6:47 (1:14)	0.8	.47	.23	.32			−.03
	P1M	7:00 (0:53)	6:47 (0:33)								−0.1
	P6M	7:27 (1:13)	6:34 (1:20)						0.9	.47	.50
Time in bed, hh:mm	Baseline	8:12 (1:11)	7:57 (1:06)	8:07 (1:11)							
	Post-treatment	7:58 (0:46)	7:52 (0:55)	8:06 (1:20)	0.1	.90	−.10	.01			−.11
	P1M	7:48 (0:54)	7:56 (0:49)								−.35
	P6M	8:12 (0:58)	7:46 (0:49)						1.4	.25	.21
Sleep onset latency, min	Baseline	41.6 (26.2)	34.2 (18.0)	35.7 (30.0)							
	Post-treatment	23.2 (16.9)	28.6 (21.7)	33.5 (22.4)	**3.7**	**.03**	−.50*	−.11			−.49
	P1M	26.1 (20.6)	25.3 (14.3)								−.34
	P6M	23.0 (15.6)	30.3 (25.5)						2.0	.13	−.55
Sleep efficiency,%	Baseline	81.1 (9.3)	82.1 (9.6)	81.3 (12.1)							
	Post-treatment	89.5 (7.4)	87.5 (6.6)	85.0 (8.8)	**3.4**	**.04**	.50*	.37			.18
	P1M	89.8 (5.6)	86.3 (6.2)								.38
	P6M	89.8 (9.4)	84.4 (14.4)						0.7	.54	.34
Wake after sleep onset, min	Baseline	15.4 (14.7)	15.8 (21.0)	21.2 (51.5)							
	Post-treatment	8.7 (26.2)	8.5 (13.4)	16.2 (24.2)	0.0	.97	−.02	−.05			.19
	P1M	14.2 (37.5)	10.7 (13.1)								.33
	P6M	8:7 (14.8)	8.3 (14.1)						0.4	.74	.15
Dysfunctional sleep belief (DBAS)	Baseline	5.9 (1.2)	6.5 (1.4)	5.9 (1.5)							
	Post-treatment	3.8 (1.8)	5.3 (1.7)	6.4 (1.4)	**20.4**	**<.001**	−1.78**	−.88*			−.80*
	P1M	3.6 (1.9)	5.0 (1.7)								−.63
	P6M	3.4 (1.6)	4.9 (1.7)						2.9	**.04**	−.80*
PSAS											
Somatic arousal (PSAS)	Baseline	14.4 (4.9)	16.5 (6.0)	14.6 (4.6)							
	Post-treatment	13.0 (5.1)	14.3 (5.2)	16.1 (5.7)	**4.9**	**.01**	−.52*	−.70*			.23
	P1M	12.7 (5.5)	13.5 (5.0)								.37
	P6M	11.9 (5.8)	12.8 (4.9)						1.1	.35	.30
Cognitive arousal (PSAS)	Baseline	28.8 (7.5)	29.1 (7.0)	27.3 (6.9)							
	Post-treatment	20.9 (7.4)	22.9 (6.7)	26.2 (7.3)	**6.7**	**.002**	−1.36**	−.64			−.26
	P1M	19.44 (7.2)	19.8 (6.8)								.04
	P6M	17.6 (7.5)	19.8 (7.3)						1.1	.36	−.25
Prearousal activities	Baseline	31.0 (5.3)	31.6 (7.7)	29.1 (6.3)							
	Post-treatment	22.7 (7.3)	22.8 (6.1)	30.1 (7.2)	**15.0**	**<.001**	−1.47**	−1.18**			.01
	P1M	21.5 (6.7)	22.8 (8.3)								−.08
	P6M	20.3 (6.3)	21.7 (7.0)						0.2	.89	−.19
Eat/drink near bedtime	Baseline	11.5 (3.7)	13.2 (4.4)	12.9 (4.4)							
	Post-treatment	11.2 (3.4)	11.1 (3.4)	13.6 (4.7)	1.7	.19	−.16	−.36			.27
	P1M	11.0 (3.6)	10.8 (4.8)								.30
	P6M	9.7 (3.8)	10.5 (4.3)						1.1	.35	.05
Sleep environment	Baseline	18.6 (6.4)	20.1 (8.8)	19.3 (7.9)							
	Post-treatment	16.3 (6.2)	17.7 (7.4)	20.0 (6.0)	1.5	.24	−.34	−.19			.05
	P1M	14.9 (6.2)	16.5 (8.0)								.03
	P6M	13.9 (6.2)	14.8 (6.6)						0.2	.93	−.20

(*continued on next page*)

Table 2
Continued

Variable	Assessment timepoint	GT	ESH	WL	Time* group interaction		Effect size (*d*)		Time* group interaction		Effect size (*d*)
					GT, ESH versus WL[a]		GT versus WL	ESH versus WL	GT versus ESH[b]		GT versus ESH
					F	p	*d*	*d*	F	p	*d*
Sleep schedule	Baseline	26.2 (5.8)	29.0 (6.5)	25.0 (5.4)							
	Post-treatment	23.1 (6.5)	24.7 (5.7)	26.8 (5.3)	8.15	.001	−.84**	−.79*			.15
	P1M	21.3 (7.2)	23.5 (5.9)								.30
	P6M	20.7 (5.6)	24.8 (5.0)						0.5	.68	−.21

Descriptive data are presented as mean (standard deviation).
CGI-S = Clinical Global Impression–Severity; DBAS = Dysfunctional Belief Attitude Scale; ESH = email-delivered self-help; GT = group-based therapy; ISI = Insomnia Severity Index; PSAS = Pre-sleep Arousal Scale; PSQI = Pittsburgh Sleep Quality Index; WL = wait-list.
*$p < .05$, **$p < .001$.
Bold values indicate statistical significant at $p < .05$.
[a] Mixed-effect model three groups (GT, ESH, and WL) x two time points (baseline, after 1 week) interaction.
[b] Mixed-effect model two groups (GT and ESH) x four time points (baseline, after 1 week, after 1 month, after 6 months) interaction.

whereas a reduction of the ISI ≥6 points was considered as self-reported clinically meaningful improvement in insomnia. CGI-I ≤2 was considered as clinical-rated treatment response.

The analyses were conducted based on the intention-to-treat principle. Linear mixed models were used in which random effect was taken into account for repeated measures within individuals. The maximum likelihood–based method was applied to produce an unbiased estimation of intervention effect with the assumption that data were missing at random. As there was a significant difference in age and education between the groups, these variables were treated as covariates in the analyses. Two sets of liner mixed models were constructed with the first one comparing the effects of GT and ESH with the WL (2 time points x three groups) and another set to evaluate the differences in treatment effects between the GT and ESH (3 time points x two groups). Between-group Cohen's *d* was calculated by dividing the effect estimates of the mixed model by the baseline standard deviation of the outcomes [34]. Cohen's *d* of 0.20, 0.50, and 0.80 represents small, medium, and large effect sizes, respectively. All the statistical analyses were performed using Statistical Package System Software, version 24.

Results

Participants

A consort diagram of the recruitment progress is presented in Figure 1. One hundred thirty-five eligible participants (mean age: 20.0 ± 2.5 years, female: 67.4%) were enrolled in the study and were randomly assigned to one of the three groups (GT, ESH, or WL). There were no significant differences between the groups in gender, depression diagnosis, and other sleep and mood outcomes (all *p*'s > .05), except that the three groups differed in education level ($p = .03$) and age ($p = .01$) (Table 1). The average duration of insomnia was 3.2 years (standard deviation = 2.9).

Treatment completion and attrition

In the GT group, 41 (90.1%), 2 (4.4%), and 2 (4.4%) completed at least six sessions, five sessions, and less than five sessions, respectively, whereas for the ESH group, 27 (62%), 2 (4.4%), and 17 (37.8%) received at least six sessions, five sessions, and less than five sessions, respectively. The study dropout rate was higher in the email and WL groups (GT vs. ESH vs. WL: 4.4%, 37.8%, 33.3%, $\chi^{2=}15.6$, $p < .001$). Baseline comparison showed that those dropouts had less severe depressive symptoms [HRSD, t (133) = 3.0, $p = .003$], insomnia symptoms [ISI: t (133) = 2.5, $p = .01$], and physical fatigue [t (133) = 2.1, $p = .03$] and had better physical health [Kidscreen-Physical well-being score, t (133) = −2.9, $p = .004$] than those participants who retained in the study.

Comparisons of group and email CBT-I with wait-list controls after treatment

Treatment effects on sleep-related outcomes. Table 2 presents the changes of sleep measures across the three groups over the study period. Mixed-effect analysis indicated that both GT and ESH groups showed a significant reduction in the ISI score after treatment compared with the WL group (GT vs. WL: Cohen's $d = -1.03$; $p < .001$; ESH vs. WL: $d = -0.63$; $p = .03$). The GT group also showed better sleep quality after the intervention (GT vs. WL: $d = -1.04$; $p < .001$) (Table 2). Both treatment groups had greater overall clinical improvement (GT: $d = -1.54$; $p < .001$; ESH: $d = -0.76$; $p = .03$) in relative to the WL group after treatment. Regarding the sleep diary measures, the GT group had shorter sleep onset latency ($d = -0.50$; $p = .01$) and higher sleep efficiency ($d = 0.50$; $p = .01$) than the WL group after treatment.

Fewer sleep-related dysfunctional beliefs as assessed by the DBAS (GT vs. WL: $d = -1.78$; $p < .001$; ESH vs. WL: $d = -0.88$; $p = .002$) and less presleep somatic arousal (GT vs. WL: $d = -0.52$; $p = .03$; ESH vs. WL: $d = -0.70$; $p = .003$) were observed in both treatment groups than in the WL group after treatment (Table 2). However, only the GT group had a significant reduction in cognitive arousal after treatment (GT vs. WL: $d = -1.36$; $p < .001$). Moreover, both treatment groups had more regular sleep schedule (GT vs. WL: $d = -0.84$; $p < .001$; ESH vs. WL: $d = -0.79$, $p = .001$) and fewer presleep arousal activities (GT vs. WL: $d = -1.47$; $p < .001$; ESH vs. WL: $d = -1.18$, $p < .001$) than the WL group after treatment.

Treatment effects on mood and daytime functioning outcomes

The results on the mood symptoms, suicidality, daytime sleepiness, fatigue, and health-related quality of life across all

Table 3
Comparisons of mood symptoms, suicidality, and daytime functioning at all time points across three groups

Variables	Time point	GT	ESH	WL	Time* group interaction		Effect size (*d*)		Time* group interaction		Effect size (*d*)
					GT, ESH versus WL[a]		GT versus WL	ESH versus WL	GT versus ESH[b]		GT versus ESH
					F	p			F	p	
Clinician-rated depressive symptoms											
HRSD	Baseline	10.1 (5.2)	8.6 (4.6)	8.8 (5.0)							
	Post-treatment	3.6 (3.7)	5.4 (4.7)	8.0 (5.9)	**9.9**	**<.001**	−1.0**	−.47			−.61*
	P1M	3.8 (3.9)	4.6 (4.4)								−.34
	P6M	3.5 (3.9)	7.0 (6.2)						**3.8**	**.01**	−.86*
HRSD (without sleep item)	Baseline	7.3 (4.9)	6.2 (4.1)	6.5 (4.6)							
	Post-treatment	3.1 (3.3)	4.3 (3.9)	6.0 (5.2)	**5.46**	**.005**	−.68*	.28			
	P1M	2.9 (3.4)	3.6 (3.8)								−.46*
	P6M	2.7 (3.3)	5.5 (5.1)						**2.9**	**.039**	−.27
Self-reported mood symptoms											−.75*
Depression (HADS_D)	Baseline	7.8 (3.8)	7.0 (3.8)	7.4 (3.3)							
	Post-treatment	6.2 (4.2)	5.8 (4.4)	6.9 (4.1)	0.9	.43	−.23	−.32			.06
	P1M	6.1 (4.3)	5.4 (3.9)								.11
	P6M	5.8 (4.4)	5.1 (3.3)						0.1	.96	.04
Anxiety (HADS_A)	Baseline	9.5 (3.3)	9.1 (3.9)	9.7 (3.7)							.05
	Post-treatment	7.5 (3.4)	6.5 (3.4)	8.7 (3.6)	0.5	.60	−.18	−.22			−.19
	P1M	6.9 (4.2)	6.3 (3.5)								−.28
	P6M	6.9 (3.3)	7.1 (4.3)						0.6	.61	
Suicidality (DSISS)	Baseline	1.5 (2.2)	0.7 (1.4)	0.8 (1.5)							
	Post-treatment	1.0 (2.4)	0.8 (1.8)	0.9 (1.4)	2.9	.06	−.29	.14			−.40
	P1M	0.7 (1.7)	0.5 (1.4)								−.29
	P6M	0.5 (1.4)	1.0 (1.9)						**3.0**	**.04**	−.64*
Daytime functioning outcomes											
Daytime sleepiness (PDSS)	Baseline	18.7 (4.3)	18.0 (4.1)	19.2 (4.9)							
	Post-treatment	16.7 (4.9)	15.5 (3.7)	19.8 (5.3)	**3.9**	**.02**	−.58*	−.59*			.05
	P1M	15.8 (5.0)	14.7 (5.5)								.07
	P6M	13.8 (4.0)	15.0 (4.7)						1.3	.30	−.45
Fatigue											
General fatigue (MFI_GF)	Baseline	15.0 (2.4)	15.3 (2.5)	15.0 (2.6)							
	Post-treatment	13.3 (3.4)	12.8 (3.5)	14.9 (3.1)	**4.95**	**.01**	−.56*	.96*			.42
	P1M	12.9 (3.6)	12.8 (2.8)								.22
	P6M	12.4 (3.8)	13.3 (2.7)						1.2	.31	−.29
Physical fatigue (MFI_PF)	Baseline	14.0 (3.9)	14.1 (2.8)	13.1 (4.3)							
	Post-treatment	13.3 (4.3)	13.3 (3.2)	13.3 (4.0)	.36	.70	−.02	−.18			.19
	P1M	12.2 (4.5)	12.7 (3.4)								.07
	P6M	12.1 (4.1)	12.9 (2.6)						0.4	.74	−.10
Reduced activity (MFI_RA)	Baseline	13.1 (3.7)	12.9 (3.3)	13.1 (3.3)							
	Post-treatment	12.1 (3.2)	12.0 (3.1)	13.2 (3.1)	0.9	.40	−.22	.30			.03
	P1M	12.0 (3.6)	11.4 (3.6)								.23
	P6M	11.3 (3.5)	11.9 (3.6)						0.9	.47	−.12
Reduced motivation (MFI_RM)	Baseline	12.5 (3.1)	11.6 (3.4)	12.2 (2.6)							
	Post-treatment	11.2 (3.1)	11.0 (2.7)	12.5 (2.8)	2.3	.11	−.56	.34			−.19
	P1M	11.2 (3.1)	10.9 (3.4)								−.09
	P6M	11.2 (3.1)	11.9 (3.4)						0.7	.54	−.42
Mental fatigue (MFI_MF)	Baseline	14.0 (3.4)	14.0 (3.1)	14.0 (2.8)							
	Post-treatment	12.3 (3.9)	12.3 (3.4)	13.5 (3.4)	1.6	.22	−.31	−.44			.10
	P1M	11.8 (3.9)	12.2 (3.4)								−.04
	P6M	11.9 (3.7)	12.8 (3.1)						0.5	.71	−.27
Quality of life											
KIDSCREEN (physical)	Baseline	35.5 (7.8)	36.0 (7.8)	37.7 (7.7)							
	Post-treatment	37.5 (9.9)	36.3 (5.6)		1.07	.35	.25	.28			−.03
	P1M	38.3 (9.6)	38.9 (9.6)								−.35
	P6M	38.6 (9.1)	38.3 (7.4)						.79	.50	−.13
KIDSCREEN (psychological)	Baseline	34.8 (6.1)	36.5 (6.0)	36.7 (6.9)							
	Post-treatment	37.0 (5.8)	38.9 (6.5)		1.30	.28	.28	.38			−.09
	P1M	39.6 (8.6)	39.9 (9.2)								.15
	P6M	39.0 (7.4)	40.5 (6.9)						.19	.91	.01
KIDSCREEN (autonomy and parents)	Baseline	42.5 (8.1)	41.5 (7.2)	40.5 (6.0)							
	Post-treatment	43.4 (10.7)	42.9 (6.7)		.54	.58	.17	.25			−.06
	P1M	42.1 (10.7)	44.5 (11.3)								−.58
	P6M	42.2 (9.6)	42.2 (6.7)						1.86	.14	−.20
KIDSCREEN (social support and peers)	Baseline	37.9 (7.7)	39.8 (8.2)	40.7 (8.7)							
	Post-treatment	38.8 (8.9)	40.3 (10.4)		.13	.88	.07	.15			−.06
	P1M	39.8 (8.5)	39.3 (8.7)								.16
	P6M	38.5 (7.8)	40.1 (12.0)						.25	.86	−.06

(*continued on next page*)

Table 3
Continued

Variables	Time point	GT	ESH	WL	Time* group interaction		Effect size (*d*)		Time* group interaction		Effect size (*d*)
					GT, ESH versus WL[a]		GT versus WL	ESH versus WL	GT versus ESH[b]		GT versus ESH
					F	p			F	p	
KIDSCREEN (school environment)	Baseline	41.0 (5.1)	41.2 (4.7)	41.6 (5.6)							
	Post-treatment	41.4 (6.6)	43.7 (6.6)		1.31	.27	−.17	.28			−.48
	P1M	42.9 (6.4)	44.8 (7.4)								−.42
	P6M	42.5 (6.7)	41.8 (8.0)						2.09	.11	.25

Descriptive data are presented as mean (standard deviation).
CGI-S = Clinical Global Impression–Severity; DBAS = Dysfunctional Belief Attitude Scale; DSISS = Depressive Symptom Inventory Suicidality Subscale; ESH = email-delivered therapy; GF = general fatigue; GT = group-based therapy; HADS = Hospital Anxiety and Depression Scale; HAMD = Hamilton Rating Scale for Depression; ISI = Insomnia Severity Index; MF = mental fatigue; MFI = Multidimensional Fatigue Inventory; PDSS = Pediatric Daytime Sleepiness Scale; PF = physical fatigue; PSAS = Presleep Arousal Scale; PSQI = Pittsburgh Sleep Quality Index; RA = reduced activity; RM = reduced motivation; WL = wait-list.
*$p < .05$, **$p < .001$.
Bold values indicate statistical significant at $p < .05$.
[a] Mixed-effect model three groups (GT, ESH, and WL) x two time points (baseline, after 1 week) interaction.
[b] Mixed-effect model two groups (GT and ESH) x four time points (baseline, after 1 week, after 1 month, after 6 months) interaction.

time points are summarized in Table 3. There was a significant reduction in clinician-rated depression severity as assessed by using the HRSD in the GT group ($d = -1.0$, $p < .001$) but not in the ESH group ($p = .08$) compared with the WL group. A similar pattern of the results was observed even after the removal of the sleep items in the HRSD (GT vs. WL: $d = -0.68$, $p = .002$).

Daytime sleepiness and general fatigue were also significantly improved in both treatment groups compared with the WL after treatment (PDSS: GT vs. WL: d = −0.58; $p = .02$; ESH vs. WL: d = −0.59; $p = .01$; general fatigue: GT vs. WL: d = −0.56; $p = .05$; ESH vs. WL: d = −0.96; $p = .002$).

Comparisons of group versus email CBT-I

Compared with the participants in the ESH group, those in the GT group had a greater reduction in clinician-rated depression severity and overall improvement at post-treatment (HRSD: $d = -0.61$; $p = .014$; CGI-S: $d = -0.75$, $p = .04$) and 6-month follow-up (HRSD: $d = -0.86$, $p = .003$; CGI-S: $d = -0.75$, $p = .03$) (Table 3). The improvement of the depressive symptoms as measured by using the HRSD in the GT group remained pronounced even after excluding the sleep items in the analysis (post-treatment: $d = -0.46$, $p = .04$; 6-month: $d = -0.75$, $p = .01$). Moreover, compared with the ESH group, the GT group had a significantly lower suicidality score at 6-month follow-up ($d = -0.64$, $p = .01$) and had significantly fewer dysfunctional beliefs about sleep (DBAS) at post-treatment ($d = -0.80$, $p = .02$) and 6-month follow-up ($d = -0.80$, $p = .01$). There were no significant differences between the two treatment groups in all other sleep diary parameters, self-reported mood, and daytime functioning measures.

Clinical significance of treatment effects

Table 4 presents the proportion of participants who were classified as remitted and responded to treatment at the follow-up assessments. Notably, 46.5% of the participants from the GT group and 42.3% the participants from the ESH remitted from insomnia (as defined by the ISI score <8) after treatment, compared with 10% of the participants in the WL group (linear-by-linear association: $\chi^2 = 9.7$, $p = .002$). For the treatment response as indicated by a reduction of the ISI score ≥6 points, the response rates were 74.4%, 50.0%, and 23.3% for the GT, ESH, and WL groups, respectively (linear-by-linear association: $\chi^2 = 18.4$, $p < .001$). In terms of clinician-rated clinical improvement as assessed by CGI-I, 51.2% and 48.1% of participants in the GT and ESH groups, respectively, were considered to have attained a response after treatment, compared with 25.9% in the WL condition, but the differences were not statistically significant ($\chi^2 = 3.9$, $p = .10$).

Discussion

The present study aimed to investigate the effects of group-based and email self-help CBT-I compared with the wait-list group in young people. The findings supported that CBT-I either in group or email-delivered modality could improve insomnia symptoms, sleep-related dysfunctional belief, sleep hygiene practices, and daytime functioning in youths with insomnia. In addition, group-based treatment was found to result in a greater improvement in depressive symptoms and a greater reduction of suicidality.

The significant improvement in insomnia observed in both CBT-I treatment groups was consistent with the findings in the previous studies that evaluated internet-based and individual face-to-face CBT-I among adolescents [35] and a previous study that used the same email-delivered CBT-I materials in college students [17]. Notably, 42%–46% of the participants in both treatment groups achieved a remission of insomnia after treatment, and they were able to maintain this treatment effect at six-month follow-up, suggesting the potential sustained effect of CBT-I in youths. Moreover, as compared with the WL group, group-based but not email-delivered CBT-I was found to be effective in reducing sleep onset latency and improving sleep efficiency. This observation was in line with that of a previous CBT-I study conducted in adolescents, which showed the superiority of the face-to-face modality as compared with the digital approach [35].

Both group-based and email-delivered CBT-I produced considerable treatment effects on reducing dysfunctional sleep-related beliefs, presleep hyperarousal, and irregularity of sleep schedule. It is worth noting that youths in the present study had similar time in bed after the intervention and a trend of increased

Table 4
Remission and response rates based on the ISI score and clinician-rated response at follow-ups across three groups

Variable	Remission			*p* value	Response (self-rated)			*p* value	Response (clinician)			*p* value
	GT	ESH	WL		GT	ESH	WL		GT	ESH	WL	
After 1 week	46.5%	42.3%	10.0%	**.002**	74.4%	50.0%	23.3%	**<.001**	51.2%	48.1%	25.9%	.10
After 1 month	63.2%	41.7%	NA	.10	65.8%	62.5%	NA	.79	48.7%	64.0%	NA	.23
After 6 months	62.9%	60.9%	NA	.88	80.0%	56.5%	NA	.06	66.7%	47.8%	NA	.16

The between-group difference was evaluated by the chi-square test. Bold values indicate statistical significant at $p < .05$.
Remission was defined as the ISI score <8; Response (self-rated) was defined as a reduction of the ISI score from baseline to follow-up ≥6; Response (clinician-rated) was defined as the Clinical Global Impression–Improvement (CGI-I) score ≤2.
ESH = email-delivered self-help; GT = group-based therapy; ISI = Insomnia Severity Index; NA = not available; WL = wait-list.

total sleep duration, albeit not statistically significant. Given the direct and immediate effect of insufficient sleep on daytime vigilance, even a mild sleep extension has been found to alleviate daytime impairments in young people [36], which might partly explain the significant improvement in daytime functioning after the CBT-I treatment in the present study.

Group-based CBT-I additionally produced positive results in the overall clinical improvement and clinician-rated depressive symptoms as well as self-reported suicidality. Previous research has shown a close link between insomnia and psychopathology, where insomnia might contribute to or aggravate the mood symptoms and increase the risk for suicidal behaviors [3,5]. The high comorbidity of insomnia, mood problems, and suicidality suggests the possibility of shared mechanisms among these problems. Thus, it might be possible that the reduction of mood symptoms was partly due to the restoration of good sleep, implying the mediating effect of sleep in the trajectory of mood-related psychopathology. It might be also possible that relaxation strategies and cognitive restructuring in the CBT-I treatment contributed to the improvements in the mental health–related outcomes. However, there was no significant difference in self-reported mood symptoms across the three groups after treatment. One reason for the disparity might be due to the differences in the content and weighting of symptom dimensions that were addressed in the clinician-rated and self-reported measures, and clinician-rated measure has often been found to yield a larger effect size [37]. Nonetheless, the reduction in clinician-rated depressive symptoms even after the removal of sleep items might lend some support to the notion that targeting insomnia could be a potentially promising approach to improve mood problems and suicidality [38,39], especially in the youths who are thought to be more vulnerable to the development of mental illnesses.

The findings of the present study added to the existing literature that face-to-face modality might be superior to self-help approach in terms of improving cognitive and mood aspects in young people [40]. The differential effects of these two treatment modalities might be due to greater time investment, more intensive interactions and discussions with peers or the therapist, and the provision of individualized feedback during the face-to-face treatment, while the self-help group only received unguided text-based content. In addition, the self-help group might have a lower motivation during the intervention than the face-to-face group. This low motivation could also be the potential reason for the relatively high dropout rate in the email-delivered CBT-I group as observed in this study. Motivation is considered as an important component that may contribute to treatment adherence and compliance in psychosocial interventions. In this regard, motivational enhancement component is often added at the beginning of the psychological interventions to enhance treatment compliance and outcomes [41]. For example, a previous study has shown that providing motivational support to self-help CBT-I could improve treatment efficacy [42]. In addition, those participants who dropped out from the study tended to have better mood and physical health and fewer insomnia symptoms than those who retained in the study. We speculated that those individuals who had symptoms improved spontaneously during the study would perceive the treatment as less necessary for their condition and thus would be less motivated to engage and complete the treatment [43]. The dropout rate in this study was slightly higher than the figures reported in the previous trials (ranging from 11% to 15%), which incorporated guided or supported online CBT-I [35,42–45]. There was also evidence showing that young people were more likely to terminate online treatment than adults, underscoring the need to establish individualized and interactive online treatment program as well as motivational components to reduce the high attrition rate [46].

The findings of the present study should be interpreted with cautions given some limitations. First, a relatively high dropout rate (38%) and a lower completion rate of the sleep diary in the email-delivered group might dampen the assessment of the study effects. Second, the present study incorporated a WL control rather than an active comparator. It raised a possibility that the treatment effect might be due to the contact time rather than the treatment itself. Third, the age range of the study sample covers both adolescents and young adults with more undergraduate students in the email-delivered group, albeit that the age and education level were controlled for in the analysis. It remained unclear why the email-delivered group had a higher education level than the other two groups. It might raise a potential concern about the process of the randomization. However, it is worth mentioning that other demographic and clinical factors, such as sleep-related symptoms, mood, and dysfunctional beliefs about sleep, were similar at baseline across the three groups, which supported the adequacy of randomization. Moreover, although the age groups of the recruited samples in this study might allow for wider generalizability of our findings, there might be a concern given the distinct sleep features of the adolescents and young adults. It might be possible that younger adolescents would react differently from those older adolescents or young adults toward the CBT-I treatment, albeit that we tried to include age-appropriate materials in the treatment package. Indeed, our final recruited sample only had two participants who were aged below 15 years. In other words, most of the participants fell into the category of “youth” as defined by the WHO (15–24 years). Finally, this study could be strengthened by a longer-term follow-up duration (e.g., 12-month) to evaluate any possible delayed effects. There were also no formal measures of

cost-effectiveness and adverse effects to compare face-to-face group-based versus email-deliveredtreatments.

Taken together, the findings of the present study supported the efficacy of both group-based and self-help CBT-I in treating youth insomnia, whereas face-to-face therapy demonstrated superior effects on improving mood-related outcomes. Given the challenges associated with in-person treatments, self-help interventions could be potentially promoted as an alternative insomnia treatment option to the youths, especially when traditional face-to-face treatment is not readily available. To maximize the treatment effect of self-help CBT-I, future research should explore the strategies to increase motivation and consider the unique sleep characteristics when designing the treatment programs so as to enhance the compliance and adherence in the youth population.

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jadohealth.2021.11.005.

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