

# Treating depression with a smartphone-delivered self-help cognitive behavioural therapy for insomnia: Study protocol for a parallel group randomized controlled trial

**Victoria Ka-Ying Hui**

University of Hong Kong

**Christy Yim-Fan Wong**

University of Hong Kong

**Eric Ka-Yiu**

University of Hong Kong

**Fiona Yan-Yee Ho**

Chinese University of Hong Kong

**Christian S Chan** (✉ [shaunlyn@hku.hk](mailto:shaunlyn@hku.hk))

University of Hong Kong <https://orcid.org/0000-0003-2616-5199>

---

## Study protocol

**Keywords:** major depression, insomnia, cognitive behavioral therapy for insomnia, sleep disturbance, smartphone, internet intervention

**Posted Date:** March 16th, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-17347/v1>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

**Version of Record:** A version of this preprint was published on October 9th, 2020. See the published version at <https://doi.org/10.1186/s13063-020-04778-1>.

# Abstract

## Background

Depression is a major public health concern. Emerging research has shown that cognitive behavioural therapy for insomnia (CBT-I) is effective in treating individuals with comorbid insomnia and depression. Traditional face-to-face CBT-I encounters many obstacles related to feasibility, accessibility, and help-seeking stigma. CBT-I delivered via smartphone application could be a potential solution. This paper aims to report a protocol designed to evaluate the efficacy of a self-help smartphone-based CBT-I, compared to a waitlist control, for people with major depression and insomnia.

## Methods

A two-arm parallel randomized controlled trial is conducted in a target sample of 285 non-suicidal Hong Kong Chinese older than 17 years of age with major depression and insomnia. Participants complete an online rapid screening, followed by a telephone diagnostic interview. Those who meet the eligibility criteria are randomized in a ratio of 1:1 to receive either CBT-I immediately or to a waitlist control condition. The CBT-I consists of six weekly modules and is delivered through a smartphone application proACT-S. This smartphone app has been pilot tested and revamped to improve user experience. An online randomized algorithm is used to perform randomization to ensure allocation concealment. The primary outcomes are changes over the measurement points in sleep quality, insomnia severity, and depression severity. The secondary outcomes include changes over the measurement points in anxiety, subjective health, treatment expectancy, and acceptability of treatment. Assessments are administered at baseline, post-intervention, and 6-week follow up. The recruitment is underway. Important adverse events, if any, are documented. Multilevel linear mixed model based on intention-to-treat principle will be conducted to examine the efficacy of the CBT-I interventions.

## Discussion

It is expected that proACT-S is an efficacious brief sleep-focused self-help treatment for people with major depression and insomnia. If proven efficacious, due to its self-help nature, proACT-S may be applicable as a community-based early intervention, reducing the burden of the public healthcare system in Hong Kong.

## Background

Major Depressive Disorder (MDD) is poses a significant health problem. In Hong Kong, the 12-month prevalence rate of MDD among adults is estimated at 8.4% [1]. Sleep disturbance, in particular insomnia, is a frequent symptom of MDD. It has been estimated that as many as 90% of patients with depression have sleep-quality related complaints [2]. Furthermore, in addition to being a symptom, insomnia could contribute to MDD symptom maintenance and the development of subsequent major depressive episodes [3]. A review of 21 prospective studies found that insomnia is a predictor of depression and doubles the risk for depression [4]. One longitudinal study of 300 pairs of twins also found that sleep

problems predict later depressive symptoms [5]. In Hong Kong, it has been found that sleep disturbances predict suicide attempts among outpatient psychiatric patients [6].

There is strong evidence to support the efficacy and effectiveness of cognitive-behavioural therapy (CBT) in the treatment of both MDD [7] and insomnia [8, 9]. Given their high co-occurrence [10], it has been suggested that treatment for depression should be augmented with a sleep-focused intervention for patients with both symptoms. In fact, sleep treatments, such as cognitive-behavioural therapy for insomnia (CBT-I), have been found to attenuate non-sleep symptoms of MDD [11].

Despite its efficacy in tackling MDD, there exist multiple barriers that prevent patients from receiving CBT in many parts of the world, including Hong Kong. Traditionally, CBT for depression is offered through weekly in-person sessions delivered by a professional therapist for 10–24 weeks. However, the over-stretched public healthcare system in Hong Kong cannot currently afford such frequency of care. The median waiting time for new routine cases ranges from 16 weeks to 61 weeks [12] and the typical interval between sessions exceeding 2 to 3 months. Moreover, cultural barriers, especially stigma towards mental illnesses, are also hindering help-seeking behaviours in Hong Kong [13]. Many Chinese patients would see their illness as a source of shame, holding the belief that mental health problem is a result of inferior origins, failure of parents, or the sins of one's ancestors [14]. Their illness could also cause unfavourable social evaluation and undermine help-seeking behaviours [15].

To overcome these structural and cultural barriers in the treatment of depression, self-help treatments, specifically smartphone-based programs, is proposed to be an economically viable and culturally acceptable mode to deliver empirically supported interventions. In contexts with scarce resources and strong stigma attached to mental illnesses, self-help treatments are feasible alternatives to professionally delivered treatments. With the increasing development and accessibility of technology, Internet and smartphone-based self-help treatments are becoming more readily available and increasingly popular. Emerging evidence suggests that patients with mild to moderate MDD are receptive and respond well to computerized CBT [16]. In an RCT examining Internet-based CBT for depression, 80% of participants reported satisfaction towards the treatment received, and 74% of participants felt the program was equal to or better than a “real” therapist [17]. Similarly, Internet-based self-help CBT-I is found to significantly reduce both insomnia and depression severity [18]. The effects of internet-based CBT-I on improving insomnia severity, sleep quality, and depression have been supported by multiple meta analyses (e.g., [19–21]).

Not only are self-help treatments efficacious and effective, they are often preferred over traditional psychotherapy in places where mental health stigma remains prevalent. In a study conducted in Hong Kong examining the 12-month prevalence of major depressive episode ([1]), large proportions of patients considered self-help as their preferred treatment for depression, over general medical, mental health specialty, and traditional Chinese medicine. CBT-I, in particular, is more acceptable to this population as the treatment for sleep might be perceived as more “physical” and less “psychological” than treatments for depression [22]. This is confirmed through the high receptiveness of Internet-based self-help CBT-I in a

Hong Kong RCT [23]. With the high degree of smartphone penetration (85.8%) in Hong Kong [24], smartphone application might be another promising platform to provide self-help treatment there.

## Objectives

This paper describes the protocol for a two-arm parallel RCT study that compares the efficacy of a smartphone-based self-help CBT-I with a waitlist control group in treating people with MDD and insomnia in Hong Kong. This self-help treatment is delivered through “proACT-S”, which is a smartphone application developed by the corresponding author’s research team. Results from a pilot study showed that proACT-S was efficacious for treating insomnia and was positively received by the users [23]. The current RCT is designed to test the efficacy of proACT-S in treating people with MDD and insomnia. Participants’ change in depressive and insomnia symptoms after the CBT-I intervention will be compared with a waitlist control condition. The rationale for choosing waitlist control as the comparison condition is twofold: (1) it allows researchers to determine the effect of the intervention against not receiving treatment during the same trial period; and (2) it ensures that all participants will eventually receive treatment.

It is hypothesized that, after the intervention, participants in the CBT-I condition will report a greater decrease in poor sleep quality, depression severity, and insomnia severity than those in the waitlist control condition. It is also hypothesized that the reduction in poor sleep quality, depression severity, and insomnia severity observed in the CBT-I condition will be maintained at 6-week follow-up. Furthermore, it is hypothesized that participants in the waitlist control condition will report a significant decrease in poor sleep quality, depression severity, and insomnia severity after receiving CBT-I.

## Methods

### Trial design

This is a two-arm, with equal randomization (1:1 allocation ratio) parallel, superiority RCT. It compares a self-help smartphone-based CBT-I intervention to a waitlist control condition. Prior to trial entry, participants complete a two-stage screening. Their eligibility is assessed by an online survey, followed by a telephone diagnostic interview. After the two-stage screening, the assessments, randomisation, and intervention are carried out via proACT-S. The research design is summarised in Figure 1. The full SPIRIT checklist is provided as Additional file 1.

### Study setting

This RCT is conducted in Hong Kong, where the 12-month prevalence of MDD among adults was estimated at 8.4% [1], and the weighted prevalence of insomnia among adults was 39.4% [25]. The Hong Kong extradition protests began in June 2019 (i.e., three months after the recruitment) and have

continued since then. The social turmoil arising from the protests is likely to trigger a mental health crisis, as revealed by a longitudinal survey finding that nearly one in ten people in Hong Kong are suffering from probable depression [26]. It is believed that many participants in this study will be affected by the social turmoil, which may have a bearing on the CBT-I efficacy.

## Eligibility criteria

Individuals are invited to participate in this study if they fulfil the eligibility criteria of a two-stage screening. Stage 1 is an online rapid screening and is conducted in Chinese language. The inclusion criteria are: (1) Hong Kong residents; (2) age  $\geq 18$  years; (3) predominant complaint of difficulty initiating or maintaining sleep or early morning awakening or non-restorative sleep with associated distress or impairment in social, occupational and other important areas of functioning for at least three nights per week for at least three months; (4) Insomnia Severity Index [27] score  $\geq 8$ ; (5) Patient Health Questionnaire (PHQ-9; [28]) score  $\geq 10$ ; (6) being able to read Chinese and type Chinese or English; (7) have a smartphone device (iOS or Android operating system) with Internet access; (8) have a regular email address; and (9) willing to give informed consent and comply with the trial protocol.

The exclusion criteria for the Stage 1 online rapid screening are: (1) Beck Depression Inventory II (BDI-II) suicidal ideation score  $\geq 2$ ; or (2) receiving psychological treatment at least once per month; or (3) former proACT-S pilot clinical trial participants; or (4) currently taking prescribed psychiatric drugs such as antidepressants, tranquilizers, sleeping pills regularly; or (5) carrying a diagnosis of psychosis or schizophrenia; or (6) participating in any other academic studies or clinical trials related to insomnia and/or depression.

Stage 2 is a telephone diagnostic interview screening and is conducted in Cantonese. The inclusion criteria are: (1) difficulty initiating sleep, maintaining sleep, or early-morning awakening with inability to return to sleep at least once in the past two weeks; and (2) International Statistical Classification of Diseases and Related Health Problems—Tenth Revision (ICD-10) diagnosis of depression (F32.00, F32.01, F32.10, F32.11, F32.2). The first inclusion criterion is developed with reference to the Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition (DSM-5, [29]) insomnia disorder diagnostic features. Difficulty initiating sleep is defined by a subjective sleep latency greater than 30 minutes, difficulty maintaining sleep is defined by frequent awakenings or problems returning to sleep within 30 minutes after awakenings, and early-morning awakening is defined by awakening at least 30 minutes before the scheduled time and the total sleep time before the awakening is less than 6.5 hours. The second inclusion criterion is based on the modified Chinese version of the Revised Clinical Interview Schedule (CIS-R, [30]) algorithm for ICD-10 Mild depressive episode without somatic symptoms (F32.00). It consists of four conditions: (1) minimum duration of the depressive episode is two weeks; (2) at least two typical symptoms of depression—depressed mood, loss of interest, fatigue—are present in the past two weeks; (3) at least two of the other symptoms described—reduced concentration, reduced self-esteem, ideas of guilt, pessimism about future, suicidal ideation, disturbed sleep, change in appetite with

corresponding weight change—are present in the past two weeks; (4) the 12-item Short-Form Health Survey Version 1 (SF–12 Version 1) [31] norm-based mental component score  $\leq 45$ . Because no epidemiological research has been conducted to assess the screening utility of the SF–12 Version 1 mental health component scale for diagnosable depression in Hong Kong Chinese population, the cut-off score of  $\leq 45$  was chosen with reference to a study that assessed its diagnostic accuracy to predict depression in the Australian general population [32].

The exclusion criteria for the Stage 2 telephone diagnostic interview screening are: (1) having concurrent psychological treatment at least once per month; or (2) currently taking prescribed psychiatric drugs such as antidepressants, tranquilizers, sleeping pills regularly; or (3) carrying a diagnosis of psychosis or schizophrenia; or (4) participating in any other academic studies or clinical trials related to insomnia and/or depression; or (5) having current suicidal plans or acts or have had suicidal plans or acts within the past 12 months.

After the two-stage screening, eligible participants are withdrawn if, during the main study trial, they: (1) have concurrent psychological treatment at least once per month; or (2) are taking prescribed psychiatric drugs such as antidepressants, tranquilizers, sleeping pills regularly; or (3) are being diagnosed with psychosis or schizophrenia; or (4) are participating in any other academic studies or clinical trials related to insomnia and/or depression; or (5) have suicidal ideations defined as scoring  $\geq 2$  on the BDI-II suicidal ideation item; or (6) have experienced serious diseases, significant life events, hospitalization, or fatalities; or (7) withdraw their consent; or (8) do not complete each assessment within two weeks, do not submit consent within two weeks after proACT-S personal account registration, or do not log into proACT-S within two weeks after random group assignment. In addition, participants in the waitlist control group who fail the cross-condition contamination check are withdrawn. Participants in the waitlist control group are withdrawn if: (1) they have viewed part or all treatment module content as shown by people who are undergoing this study's treatment or who have completed this study's treatment, or who are very familiar with proACT-S (except the proACT-S project team); or (2) they have watched part or all of the treatment module videos included in proACT-S; or (3) they have completed part or all of the treatment module homework in proACT-S.

## **CBT-I intervention**

The self-help CBT-I treatment content is based on the translated Chinese version of a well-established CBT-I treatment manual entitled “Insomnia: A Clinician’s Guide to Assessment and Treatment” [33]. CBT-I aims at changing dysfunctional cognitive beliefs and maladaptive behaviours that contribute to the maintenance of insomnia. The self-help CBT-I treatment is delivered in Chinese language in six consecutive weekly modules via proACT-S. Duration of each module is around 45 to 60 minutes. The content of each treatment module is displayed in Figure 3.

proACT-S has been pilot tested in a sample of 32 Hong Kong Chinese participants [34] and, later, revamped to improve user experience. One current recommendation for engaging app user was to reduce

the amount of text and, instead, used videos to deliver treatment content [35]. Therefore, some text-based materials are enhanced by animations. Following the literature recommendations [36, 37], more interactive components has been incorporated into the app. In particular, proACT-S now provides (a) a clear timeline to indicate the start date for each assessment and treatment module; (b) indicators for module and assessment completion; (c) more prompts for the user to follow in completing the weekly homework; (d) a modifiable sleep diary that accommodates the sleep pattern of shift-workers; and (e) individualized homework feedback.

Reasons for discontinuation of CBT-I may include, but are not limited to, the following: (1) participants' decision to discontinue treatment at any time for any reason; and (2) principal investigator's decision to terminate treatment for the participants' safety reasons at any time.

## Outcomes

### Primary outcomes

*Depression severity.* The 20-item Center for Epidemiologic Studies Depression Scale [38] is used to measure participants' severity of depressive symptoms during the past week. Each item is rated on a 4-point Likert scale, ranging from "less than 1 day" to "5–7 days". It has been validated in a Hong Kong sample and has high internal consistency (Cronbach's alpha = .85, [39]).

*Insomnia severity.* The 7-item Insomnia Severity Index [40] is used to assess participants' severity of insomnia symptoms and the associated daytime impairment over the past two weeks. Each item is rated on a 4-point Likert scale, ranging from "not at all" to "extremely". It has been validated in Hong Kong samples [41, 42] and has high internal consistency (Cronbach's alpha = .81, [42]).

*Sleep quality.* The 19-item Pittsburgh Sleep Quality Index [43] is used to measure participants' sleep quality and disturbances during the past month. It has seven components, namely, sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of hypnotics, and daytime dysfunction. Each subscale is converted to a scale of 0 to 3. It has validated in Hong Kong samples [25] and has good reliability (Cronbach's alphas range from .59 to .63, [44]).

### Secondary outcomes

*Subjective health.* The SF-12 Version 1 [31] is used to measure participants' subjective physical and mental health status. The SF-12 Version 1 is scored using the recommended norm-based scoring with a mean of 50 and a standard deviation of 10 in the general U.S. population [31]. It has been validated in Hong Kong samples [25, 45].

*Anxiety.* The 7-item Hospital Anxiety and Depression Scale—Anxiety subscale [46] is used to measure participants' severity of anxiety symptoms during the past week. Each item is rated on a 4-point Likert

scale. It has been validated in Hong Kong samples [25, 47] and has high reliability (Cronbach's alpha = .8, [47]).

*Treatment expectancy.* The 6-item Credibility/Expectancy Questionnaire [48] has been modified to measure participants' cognitively- and affectively-based expectancy towards the treatment. The original phrase "trauma symptoms" has been changed to "depressive symptoms" or "insomnia symptoms". Four items are rated on a 9-point Likert scale, ranging from "not at all" to "very".. The remaining two items are rated on a 10-point Likert scale, ranging from "0%" to "100%".. It has been validated in cognitive behavioural therapeutic interventions for people with depression [49] or insomnia [50], and it has high internal consistency (Cronbach's alphas range from .81 to .96).

*Acceptability of treatment.* The 26-item modified Participant Acceptability/Usability Rating Scale [51] is used to measure participants' evaluation of the treatment via proACT-S on a 3-point Likert scale, ranging from "agree" to "disagree".. It has been validated in a pilot CBT-I study [34].

*Demographics.* Information about participants' age, education level, marital status, occupation, and gender is obtained from the Stage 1 online rapid screening.

*Clinical comorbidity.* The number of participants with current diagnosis of four major comorbidities (generalized anxiety disorder, phobias, obsessive compulsive disorder, and panic disorder) can be estimated from the Stage 2 telephone diagnostic interview screening.

Primary outcome assessments take place at baseline, post-intervention and 6-week follow-up for both CBT-I and waitlist control conditions. The schedule of enrolment, interventions, and assessments is summarized in Table 1.

## Participant timeline

Individuals interested in participating are invited to complete a two-stage screening. In Stage 1 online rapid screening, they will complete an online survey to review their eligibility. Those who have passed the online rapid screening will receive a link via Qualtrics to sign up for the Stage 2 telephone diagnostic interview screening. These telephone interviews are conducted by project assistants, who have been trained and supervised on the administration of the modified Chinese version of the CIS-R [30].

Five modifications have been made to the Chinese version of the CIS-R [30]. First, only CIS-R items that measure the five ICD-10 common mental disorders are selected. These five ICD-10 diagnoses are depressive episode (F32.00, F32.01, F32.10, F32.11, F32.2), generalized anxiety disorder (F41.1), phobias (F40.00, F40.01, F40.1, F40.2), obsessive compulsive disorder (F42), and panic disorder (F41.0). The remaining CIS-R items are discarded to shorten the duration of the telephone diagnostic interview so as to make the telephone interview less burdensome for the participants. Second, the timeframe for items measuring ICD-10 depressive episode has changed from "in the past week" to "in the past two weeks" to tap the 2-week requirement for DSM-5 depressive episode diagnostic criteria. Third, the CIS-R items

measuring hypersomnia are discarded as this study focuses on insomnia. The original CIS-R only measures difficulty initiating sleep; hence, this item has been expanded to include difficulty maintaining sleep and early-morning awakening for this study. Fourth, six items are added to gather information regarding the aforementioned telephone diagnostic interview screening's exclusion criteria. Fifth, the Social and Occupational Functioning Assessment Scale [52] is substituted by the SF-12 Version 1 [31] to measure participants' overall functioning to ensure minimal judgment by the trained telephone interviewers.

Individuals who do not meet the Stage 2 telephone diagnostic interview screening eligibility criteria receive a list of references related to insomnia and depression produced by the Department of Health and the Social Welfare Department under the Government of the Hong Kong SAR. Information regarding crisis hotlines and integrated community centres for mental wellness are provided to those with current suicidal plans or acts or those who have had suicidal plans or acts within the past 12 months.

Individuals who have passed the two-stage screening are directed to download proACT-S either from App Store or Google Play. Eligible participants are guided to register for their own personal account to enter the main study trial. They then complete the baseline assessment via proACT-S. After that, they are randomly assigned in a 1:1 ratio either to CBT-I condition or waitlist control condition.

Participants in the CBT-I condition start the 6-week CBT-I immediately after randomization, complete the post-intervention assessment right after they finish the treatment, and complete the follow-up assessment six weeks after the post-intervention assessment. Participants in the waitlist control group complete the post-intervention assessment six weeks after the baseline assessment, start CBT-I (equivalent to that of the CBT-I group) immediately after completing the post-intervention assessment, and complete the follow-up assessment right after they finish the 6-week CBT-I.

Emails and WhatsApp reminders are sent to participants to increase their engagement and to enhance treatment compliance. Upon completion of the study, each eligible participant will receive cash coupons of HKD \$100 as a token of appreciation for their participation. The proposed flow of participants is displayed in Figure 2.

## Sample size

The most updated meta-analysis of 28 self-help CBT-I RCTs [19] showed a significant treatment effect in alleviating depressive symptoms (Hedges'  $g = 0.35$ ) and insomnia symptoms (Hedges'  $g = 0.79$ ). It also found that the mean cumulative study attrition rates were 21.25% ( $SD = 15.31\%$ ) and 18.4% ( $SD = 18.21\%$ ) in the treatment and in the waiting-list/routine care/no treatment/psychoeducation groups, respectively. Hence, a conservative small effect size (Cohen's  $f = 0.2$ ) and attrition rate of 30% are estimated for the present study.

As software for sample size calculation for the analysis of longitudinal data using multilevel linear mixed models is unavailable, the sample size calculation is based on mixed ANCOVA using GPower 3.1. To conduct a 2 (Condition: CBT-I versus waitlist control) X 2 (Assessment: Baseline versus post-intervention) mixed ANCOVA with an alpha value set at 0.05, two-sided, 80% power to detect a small effect of 0.2 (Cohen's  $f$ ) between two groups while controlling for 12 covariates (demographics, clinical comorbidity, treatment expectancy, and acceptability of treatment), a total sample size of 199 will be required. In order to account for 30% attrition, a total sample of 285 participants will be sufficient to detect a small effect size (Cohen's  $f = 0.2$ ) for the difference in the change in primary outcomes (i.e. insomnia severity, poor sleep quality, and depression severity) from baseline to post-intervention between CBT-I condition and waitlist control condition with a two-sided 5% significance level and a power of 80%.

## Recruitment

Participants are recruited on a rolling basis through local community, posters, web-based advertisement, departmental website, social media, and institutional mass mailing. A 'proACT-S' Facebook page has also been set up for this project, where it contains the recruitment poster and local news articles related to insomnia and depression. Recruitment began in March 2019 and it is anticipated to be complete by the end of 2020.

## Allocation

One week following the completion of the baseline assessment, participants are randomly assigned in a ratio of 1:1 either to the CBT-I group or the waitlist control group using an online randomized algorithm (<https://www.php.net/manual/en/function.random-int.php>). The group assignment follows the simple randomization procedure, and is completely automated to ensure allocation concealment.

## Blinding

The principal investigator is blind to both the outcome assessment and group assignment. The research team is blind to the outcome assessment because all three assessments are self-reported and carried out via the smartphone app, but is not blind to the group assignment as research members need to send emails and WhatsApp reminders to the participants to enhance treatment compliance. Efforts are made to minimize participants' knowledge of treatment allocation by informing participants that the treatment start date is randomly assigned. Statistical analyses will be carried out by a researcher blind to the study protocol. In the unlikely event of a critical incident, the research team as well as the principal investigator will be authorized to break the blind, and carefully record it on the Case Report Form.

## Patient and public involvement

Psychiatric staffs who were involved in validating the Chinese version of the CIS-R in Hong Kong were consulted regarding the telephone diagnostic interview training, item selection and ICD–10 scoring algorithm. Clinical psychologists specialized in sleep disorders and potential end users were invited by the research team to provide feedback regarding the study design (e.g., the measures, recruitment strategies, Facebook page), as well as proACT-S revamp and beta testing.

## **Possible harms**

Adverse events, such as increased suicidal risk, hospital admission, study attrition rates, significant deterioration in primary outcomes, are monitored and recorded throughout the study trial. Treatment discontinuation for the participants' safety reasons will be made at the discretion of the principal investigator. The proportion of participants experiencing any adverse events in each group will be reported in the results of this RCT study.

## **Data analysis plan**

The principle of intention-to-treat analysis will be adopted, in which all randomised participants with missing observations from lost to follow-up or not completing outcome assessments will be handled by multiple imputation [53]. Missing data is assumed to be 5%.

Chi-square tests and independent *t*-tests will be conducted to examine if participants in the CBT-I and waitlist control conditions differ in terms of demographic characteristics, clinical comorbidity and baseline outcome scores. Multilevel linear mixed model based on intention-to-treat principle will be used to calculate between-condition mean differences in the primary outcome changes in sleep quality, insomnia and depression severity from baseline to post-intervention assessments. Multilevel linear mixed model based on intention-to-treat principle will also be used to analyse secondary outcomes of the baseline to post-intervention change in subjective health and anxiety between CBT-I and waitlist control conditions. Clustering effect, significant baseline differences in demographics, clinical characteristics and outcome variables will be adjusted for. Pair-sample *t*-tests based on intention-to-treat principle will be used to analyse changes in primary outcomes, subjective health and anxiety obtained at post-intervention and 6-week follow-up separately for each condition. All comparisons are planned with a 5% two-sided significance level. Bonferroni adjustment will be applied.

## **Ethics and dissemination**

Consent is obtained electronically for the Stage 1 online rapid screening, verbally for the Stage 2 telephone diagnostic interview screening, and via the smartphone app proACT-S for the 6-week CBT-I intervention. The consent form explains that participatory is voluntary; individuals could withdraw from the study at any time without affecting their care or treatment.

Participants directly enter their data via Qualtrics during the Stage 1 online rapid screening and via proACT-S during the main trial study. Manual data entry from trained project assistants (i.e. telephone interviewers) is required for recording participants' Stage 2 telephone diagnostic interview screening data. A Qualtrics survey that resembles the modified Chinese version of the CIS-R [30] was created to enable data entry, coding and storage, in addition to standardizing the administration of Stage 2 screening across different trained telephone interviewers. Participants' personal data are sent to the electronic server located at The University of Hong Kong, and protected using dual encryption. The principal investigator and the research team are given access to the dataset. Participants' research file may be looked at by the Human Research Ethics Committee of the University of Hong Kong in order to check that the study is being carried out correctly. Participants will not be identified by name in any report of the completed study. Their personal data will be kept for five years after publication of the first original research paper, and research data without personal identifiers will be stored for long term retention at the Community Action Research Laboratory at The University of Hong Kong.

This protocol will be published in an open access journal for public access. Researchers interested in using the de-identified dataset to test novel hypotheses could contact the corresponding author and submit a data proposal form to be reviewed by the research team. The study findings will be disseminated in peer-reviewed publications and conference presentations. Executive summaries will be made available on the proACT-S project website and disseminated to other organizations such as the funding agency and local news agencies.

## Discussion

This two-arm, parallel randomized controlled clinical study aims to compare the efficacy of a self-help CBT-I smartphone application, proACT-S, with a waitlist control group for people with MDD and insomnia. It is expected that proACT-S is an efficacious brief sleep-focused self-help treatment for people with MDD and insomnia. If proven efficacious, due to its self-help nature, proACT-S may be applicable as a community-based early intervention, reducing the burden of the public healthcare system in Hong Kong. Additionally, this may encourage wider dissemination and utilization of proACT-S within healthcare settings in Chinese-speaking regions and communities, who might be less receptive to mental health treatments due to stigmatization, as an alternative treatment option for depression. Although the sample recruitment may be biased towards those who are reluctant to seek help from healthcare professionals, this study will provide valuable evidence regarding the utility of proACT-S as a preventive tool for individuals considering face-to-face therapy or who are receptive to lifestyle medicine for depression and insomnia in Hong Kong. Given that all participants in this study are suffering from MDD and insomnia, it is believed distress arising from the prolonged Hong Kong Extradition Bill protests would make them more vulnerable to stress-related disorders, such as mood and sleep disorders [26]. Therefore, the current social turmoil brought about by the Hong Kong Extradition Bill protests may undermine the magnitude of reduction in poor sleep quality, depression severity and insomnia severity after completing this study's treatment. Nonetheless, it is hoped that undergoing the self-help CBT-I via proACT-S would bring some relief to most participants during the turbulent political times in Hong Kong.

## Trial Status

Current protocol is EA1810026, version 4, which was last updated on 15 February 2020. Recruitment began on 19 March 2019, and is anticipated to be complete by 31 December 2020.

## List Of Abbreviations

BDI-II: Beck Depression Inventory II; CBT-I: Cognitive behavioural therapy for insomnia; CIS-R: Revised Clinical Interview Schedule; DSM-5: Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition; ICD-10: International Statistical Classification of Diseases and Related Health Problems—Tenth Revision; MDD: major depressive disorder; RCT: randomized controlled trial; SF-12 Version 1: 12-item Short-Form Health Survey Version 1

## Declarations

*Ethics approval and consent to participate:* The study was approved by the University of Hong Kong Human Research Ethics Committee (EA1810026). Any important adjustments to the protocol can only be carried out if the Ethics Committee approve after thorough communication. Informed consent will be obtained from all study participant electronically for the Stage 1 online rapid screening, verbally for the Stage 2 telephone diagnostic interview screening, and via the smartphone app proACT-S for the 6-week CBT-I intervention.

*Consent for publication:* Not applicable.

*Availability of data and materials:* Not applicable.

*Competing interests:* The authors declare that they have no competing interests.

*Authors' contributions:* CSC conceived and obtained funding for this study. Study design was undertaken by the research team: VKYH, EKYM, CYFW, FYYH, and CSC. EKYM contributed to the development and revamp of the app, as well as to the technical support for data collection. CYFW and VKYH were involved in the app revamp, and they also coordinated the participant recruitment and follow-up. VKYH produced the first draft of the protocol paper with additional input from EKYM, CYFW, FYYH, and CSC. All authors contributed to the drafting of the submitted version of the study protocol. All authors approved the final version of the manuscript.

*Funding:* This study is funded by Azalea (1972) Endowment Fund. The funding body has no role in the study design; collection, analysis or interpretation of data; or writing of the manuscript. The study is sponsored by The University of Hong Kong. Contact information for the trial sponsor can be obtained directly from the corresponding author.

*Acknowledgements:* We thank Dr. Corine Wong for her involvement in the CIS-R training and for her advice on the CIS-R modification.

## References

- 1.Lee S, Tsang A, Kwok K. Twelve-month prevalence, correlates, and treatment preference of adults with DSM-IV major depressive episode in Hong Kong. *Journal of Affective Disorders*. 2007;98(1–2):129–36.
- 2.Tsuno N, Besset A, Ritchie K. Sleep and depression. *The Journal of clinical psychiatry*. 2005;66(10):1254–69.
- 3.Ford DE, Kamerow DB. Epidemiologic study of sleep disturbances and psychiatric disorders. An opportunity for prevention? *JAMA*. 1989;262(11):1479–84.
- 4.Baglioni C, Battagliese G, Feige B, Spiegelhalder K, Nissen C, Voderholzer U, et al. Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders*. 2011;135(1–3):10–9.
- 5.Gregory AM, Rijsdijk F, Lau JYF, Dahl RE, Eley TC. The direction of longitudinal associations between sleep problems and depression symptoms: A study of twins aged 8 and 10 years. *Sleep: Journal of Sleep and Sleep Disorders Research*. 2009;32(2):189–99.
- 6.Li SX, Lam SP, Yu MWM, Zhang J, Wing YK. Nocturnal sleep disturbances as a predictor of suicide attempts among psychiatric outpatients: A clinical, epidemiologic, prospective study. *The Journal of Clinical Psychiatry*. 2010;71(11):1440–6.
- 7.Gloaguen V, Cottraux J, Cucherat M, Blackburn I-M. A meta-analysis of the effects of cognitive therapy in depressed patients. *Journal of Affective Disorders*. 1998;49(1):59–72.
- 8.Thorndike FP, Ritterband LM, Gonder-Frederick LA, Lord HR, Ingersoll KS, Morin CM. A randomized controlled trial of an internet intervention for adults with insomnia: Effects on comorbid psychological and fatigue symptoms. *Journal of Clinical Psychology*. 2013;69(10):1078–93.
- 9.Morin CM, Bootzin RR, Buysse DJ, Edinger JD, Espie CA, Lichstein KL. Psychological and behavioral treatment of insomnia: Update of the recent evidence (1998–2004). *Sleep: Journal of Sleep and Sleep Disorders Research*. 2006;29(11):1398–414.
- 10.Staner L. Comorbidity of insomnia and depression. *Sleep Medicine Reviews*. 2010;14(1):35–46.
- 11.Manber R, Edinger JD, Gress JL, Pedro-Salcedo MGS, Kuo TF, Kalista T. Cognitive behavioral therapy for insomnia enhances depression outcome in patients with comorbid major depressive disorder and insomnia. *Sleep: Journal of Sleep and Sleep Disorders Research*. 2008;31(4):489–95.
- 12.Hospital Authority. Waiting time for stable new case booking at specialist out-patient clinics 2019 [Available from: [https://www.ha.org.hk/haho/ho/sopc/dw\\_wait\\_ls\\_eng.pdf](https://www.ha.org.hk/haho/ho/sopc/dw_wait_ls_eng.pdf)].

13. Mak WWS, Chong ESK, Wong CCY. Beyond attributions: Understanding public stigma of mental illness with the common sense model. *The American journal of orthopsychiatry*. 2014;84(2):173–81.
14. Tsang HWH, Tam PKC, Chan F, Cheung WM. Stigmatizing attitudes towards individuals with mental illness in Hong Kong: Implications for their recovery. *Journal of Community Psychology*. 2003;31(4):383–96.
15. Chung KF, Wong MC. Experience of stigma among Chinese mental health patients in Hong Kong. *Psychiatric Bulletin*. 2004;28(12):451–4.
16. Kaltenthaler E, Sutcliffe P, Parry G, Beverley C, Rees A, Ferriter M. The acceptability to patients of computerized cognitive behaviour therapy for depression: A systematic review. *Psychological Medicine*. 2008;38(11):1521–30.
17. Meyer B, Berger T, Caspar F, Beevers CG, Andersson G, Weiss M. Effectiveness of a novel integrative online treatment for depression (deprexis): Randomized controlled trial. *Journal of Medical Internet Research*. 2009;11(2):1–18.
18. Blom K, Jernelöv S, Rück C, Lindefors N, Kaldo V. Three-year follow-up comparing cognitive behavioral therapy for depression to cognitive behavioral therapy for insomnia, for patients with both diagnoses. *Sleep*. 2017;40(8).
19. Ho FY-Y, Chan CS, Lo W-Y, Leung JC-Y. The effect of self-help cognitive behavioral therapy for insomnia on depressive symptoms: An updated meta-analysis of randomized controlled trials. *Journal of Affective Disorders*. 2020;265:287–304.
20. Ye Y-y, Zhang Y-f, Chen J, Liu J, Li X-j, Liu Y-z, et al. Internet-based cognitive behavioral therapy for insomnia (ICBT-i) improves comorbid anxiety and depression—A meta-analysis of randomized controlled trials. *PLoS One*. 2015;10(11).
21. Zachariae R, Lyby MS, Ritterband LM, O’Toole MS. Efficacy of internet-delivered cognitive-behavioral therapy for insomnia—A systematic review and meta-analysis of randomized controlled trials. *Sleep Medicine Reviews*. 2016;30:1–10.
22. Parker G, Cheah YC, Roy K. Do the Chinese somatize depression? A cross-cultural study. *Social Psychiatry and Psychiatric Epidemiology: The International Journal for Research in Social and Genetic Epidemiology and Mental Health Services*. 2001;36(6):287–93.
23. Ho FY-Y, Chung K-F, Yeung W-F, Ng TH-Y, Cheng SK-W. Weekly brief phone support in self-help cognitive behavioral therapy for insomnia disorder: Relevance to adherence and efficacy. *Behaviour Research and Therapy*. 2014;63:147–56.
24. Census and Statistics Department. Usage of information technology and the Internet by Hong Kong resident: 2000 to 2016 2017 [Available from:

<https://www.statistics.gov.hk/pub/B71711FB2017XXXXB0100.pdf>.

25. Wong WS, Fielding R. Prevalence of insomnia among Chinese adults in Hong Kong: A population-based study. *Journal of Sleep Research*. 2011;20(1, Pt1):117–26.
26. Ni MY, Yao XI, Leung KSM, Yau C, Leung CMC, Lun P, et al. Depression and post-traumatic stress during major social unrest in Hong Kong: A 10-year prospective cohort study. *The Lancet*. 2020.
27. Morin CM, Belleville G, Bélanger L, Ivers H. The Insomnia Severity Index: Psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep: Journal of Sleep and Sleep Disorders Research*. 2011;34(5):601–8.
28. Kroenke K, Spitzer RL, Williams JBW. The PHQ–9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*. 2001;16(9):606–13.
29. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. 5th ed. Arlington, VA: Author; 2013.
30. Chan WC, Wong CSM, Chen EYH, Ng RMK, Hung SF, Cheung EFC, et al. Validation of the Chinese version of the Revised Clinical Interview Schedule: Findings from Hong Kong Mental Morbidity Survey. *East Asian Archives of Psychiatry*. 2017;27(1):3–10.
31. Ware JE, Kosinski M, Keller SD. *SF–12: How to score the SF–12 physical and mental health summary scales*. 2nd ed. Boston, MA: The Health Institute, New England Medical Center; 1995.
32. Gill SC, Butterworth P, Rodgers B, Mackinnon A. Validity of the mental health component scale of the 12-item Short-Form Health Survey (MCS–12) as measure of common mental disorders in the general population. *Psychiatry Research*. 2007;152(1):63–71.
33. Morin CM, Espie CA. *Insomnia: A clinician’s guide to assessment and treatment*. New York: Kluwer Academic/Plenum Publishers; 2003.
34. Ho FY-Y. *Low intensity psychological intervention for common mental disorders*. Hong Kong SAR: University of Hong Kong; 2017.
35. Herron C, York H, Corrie C, Cole SP. A comparison study of the effects of a story-based video instructional package versus a text-based instructional package in the intermediate-level foreign language classroom. *CALICO Journal*. 2006;23(2):281–307.
36. Juarascio AS, Goldstein SP, Manasse SM, Forman EM, Butryn ML. Perceptions of the feasibility and acceptability of a smartphone application for the treatment of binge eating disorders: Qualitative feedback from a user population and clinicians. *International Journal of Medical Informatics*. 2015;84(10):808–16.

37. Oh J, Saraswathi B, Shyam SS. Clicking, assessing, immersing, and sharing: An empirical model of user engagement with interactive media. *Communication Research*. 2018;45(5):737–63.
38. Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*. 1977;1(3):385–401.
39. Chin WY, Choi EPH, Chan KTY, Wong CKH. The psychometric properties of the Center for Epidemiologic Studies Depression Scale in Chinese primary care patients: Factor structure, construct validity, reliability, sensitivity and responsiveness. *PLoS One*. 2015;10(8).
40. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine*. 2001;2(4):297–307.
41. Liu Y, Zhang J, Lam SP, Yu MWM, Li SX, Zhou J, et al. Help-seeking behaviors for insomnia in Hong Kong Chinese: A community-based study. *Sleep Medicine*. 2016;21:106–13.
42. Yu DSF. Insomnia Severity Index: Psychometric properties with Chinese community-dwelling older people. *Journal of Advanced Nursing*. 2010;66(10):2350–9.
43. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*. 1989;28(2):193–213.
44. Lau EYY, Hui CH, Cheung S-F, Lam J. Bidirectional relationship between sleep and optimism with depressive mood as a mediator: A longitudinal study of Chinese working adults. *Journal of Psychosomatic Research*. 2015;79(5):428–34.
45. Lam CLK, Tse EYY, Gandek B. Is the standard SF–12 Health Survey valid and equivalent for a Chinese population? *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care & Rehabilitation*. 2005;14(2):539–47.
46. Zigmond AS, Snaith RP. The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*. 1983;67(6):361–70.
47. Wong JY-H, Fong DY-T. Anxiety mediates the impact of stress on psychosomatic symptoms in Chinese. *Psychology, Health & Medicine*. 2015;20(4):457–68.
48. Devilly GJ, Borkovec TD. Psychometric properties of the credibility/expectancy questionnaire. *Journal of Behavior Therapy and Experimental Psychiatry*. 2000;31(2):73–86.
49. Webb CA, Kertz SJ, Bigda-Peyton JS, Björgvinsson T. The role of pretreatment outcome expectancies and cognitive–behavioral skills in symptom improvement in an acute psychiatric setting. *Journal of Affective Disorders*. 2013;149(1–3):375–82.

50.Heim E, Rötger A, Lorenz N, Maercker A. Working alliance with an avatar: How far can we go with internet interventions? *Internet Interventions*. 2018;11:41–6.

51.Ben-Zeev D, Brenner CJ, Begale M, Duffecy J, Mohr DC, Mueser KT. Feasibility, acceptability, and preliminary efficacy of a smartphone intervention for schizophrenia. *Schizophrenia Bulletin*. 2014;40(6):1244–53.

52.American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. 4th ed. Washington, DC: American Psychiatric Association; 1994.

53.Armijo-Olivo S, Warren S, Magee D. Intention to treat analysis, compliance, drop-outs and how to deal with missing data in clinical research: a review. *Physical Therapy Reviews*. 2009;14(1):36–49.

## Table

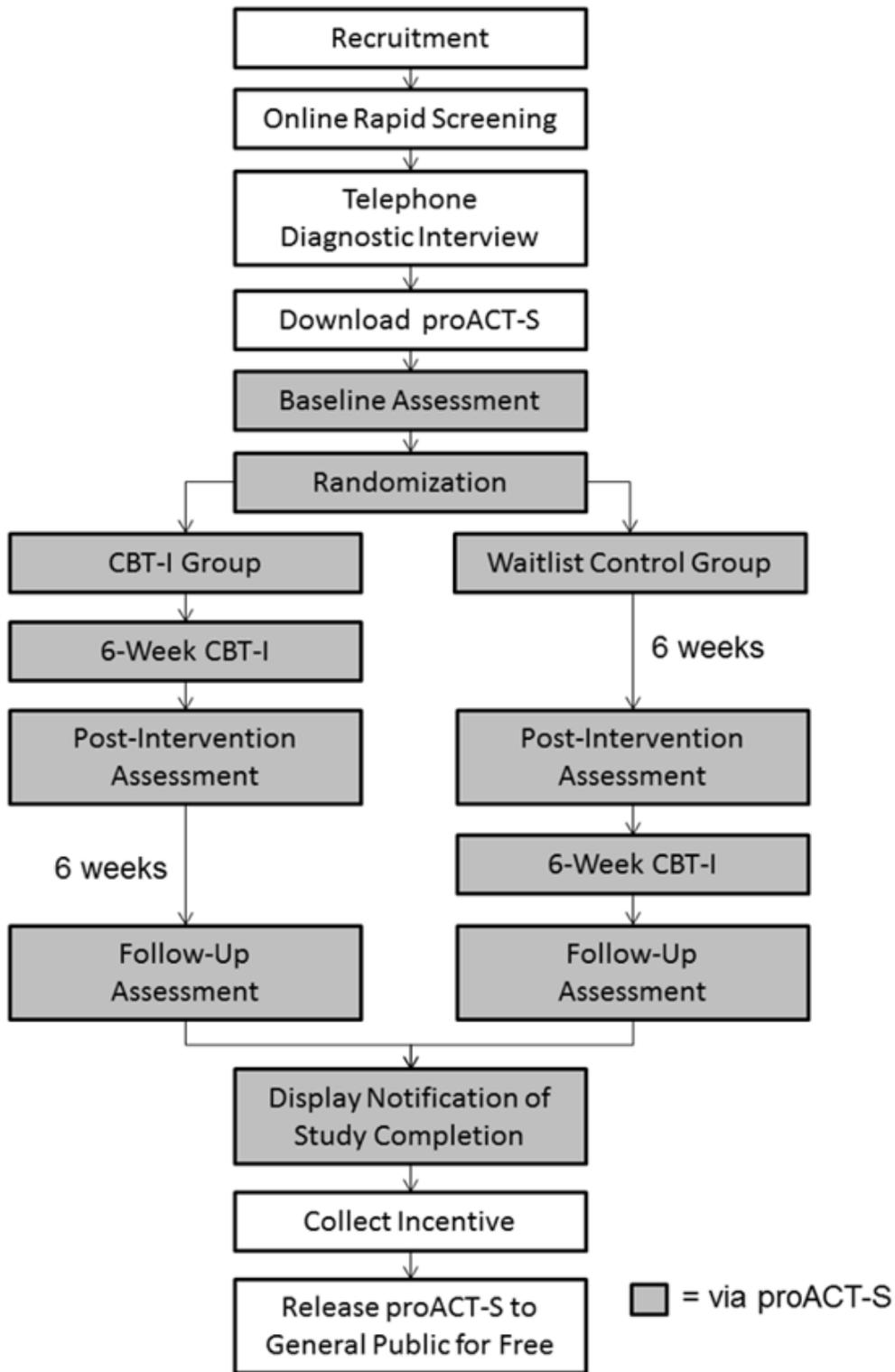
Table 1

*The Schedule of Enrolment, Interventions, and Assessments*

-	<u>Screening</u>	<u>Baseline</u>	<u>Allocation</u>	<u>Post</u>	<u>6-Week</u>			
				<u>Intervention</u>	<u>Follow-up</u>			
<b><u>TIMEPOINT (WEEK)</u></b>	-12	0	1	7	13			
<b><u>ENROLMENT:</u></b>	-	-	-	-	-			
Eligibility screen	X							
Informed consent	X	X						
Allocation			X					
-								
<b><u>INTERVENTIONS:</u></b>								
CBT-I		X	X	X	X			
Waitlist control (WLC)		X	X	X	X			
-								
<b><u>ASSESSMENTS:</u></b>								
<i>Primary Outcome Measures</i>		<u>CBT-I</u>	<u>WLC</u>		<u>CBT-I</u>	<u>WLC</u>	<u>CBT-I</u>	<u>WLC</u>
Depression severity (CES-D)		X	X		X	X	X	X
Insomnia severity (ISI)		X	X		X	X	X	X
Sleep quality (PSQI)		X	X		X	X	X	X
<i>Secondary Outcome Measures</i>		<u>CBT-I</u>	<u>WLC</u>		<u>CBT-I</u>	<u>WLC</u>	<u>CBT-I</u>	<u>WLC</u>
Subjective health (SF-12 Version 1)		X	X		X	X	X	X
Anxiety (HADS-A)		X	X		X	X	X	X
Treatment expectancy (Modified CEQ)		X	X		X			X
Treatment Acceptability (Modified PARS)		X	X		X			X
Demographics	X							
Clinical comorbidity	X							

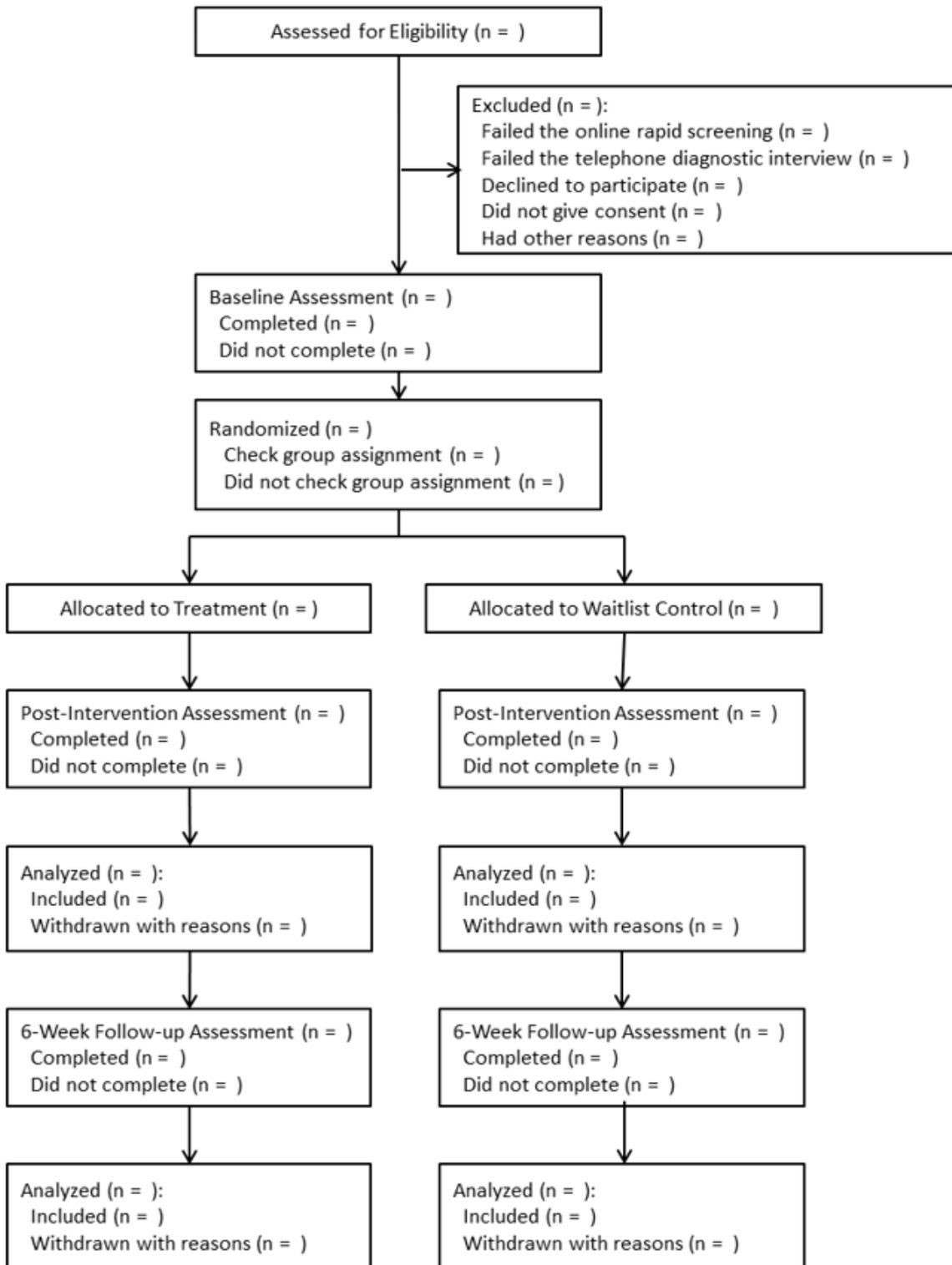
<i>Post-Screening Eligibility Assessments</i>	<u>CBT-</u> ↓	<u>WLC</u>	<u>CBT-</u> ↓	<u>WLC</u>	<u>CBT-</u> ↓	<u>WLC</u>
Withdrawal criteria			X	X	X	X
Cross condition contamination check				X		X
<i>Note.</i> CES-D (Center for Epidemiologic Studies Depression Scale); ISI (Insomnia Severity Index); PSQI (Pittsburgh Sleep Quality Index); HADS-A (Hospital Anxiety and Depression Scale–Anxiety subscale); CEQ (Credibility/Expectancy Questionnaire); PARS (Participant Acceptability/Usability Rating Scale)						

## Figures



**Figure 1**

The current RCT study design.



**Figure 2**

Proposed flow of participants.

Week 1	Content	Treatment overview  Predisposing, precipitating and perpetuating factors of insomnia
	Homework	Dysfunctional beliefs and attitudes about sleep assessment
Week 2	Content	Sleep hygiene
	Homework	Sleep hygiene assessment
Week 3	Content	Basic facts about sleep  Relaxation therapy
	Homework	Diaphragmatic breathing relaxation (daily practice)  Sleep diary (at least three diaries per week)
Week 4	Content	Sleep restriction  Stimulus control
	Homework	Sleep diary (at least three diaries per week)  Sleep restriction (sleep efficiency $\geq$ 90%; 15 minutes per week maximum)
Week 5	Content	Cognitive restructuring  Constructive worry  Cognitive distortions
	Homework	Thought record
Week 6	Content	Integration and review of all treatment content  Shift work

**Figure 3**

Content of each weekly CBT-I treatment module.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SPIRIT2013ChecklistproACTsDraft4VKYH15Feb2020.doc](#)