A Systematic Review of Cognitive Behavioral Therapy and Behavioral Activation Apps for Depression

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Abstract

Depression is a common mental health condition for which many mobile apps aim to provide support. This review aims to identify self-help apps available exclusively for people with depression and evaluate those that offer cognitive behavioural therapy (CBT) or behavioural activation (BA). One hundred and seventeen apps have been identified after searching both the scientific literature and the commercial market. 10.26% (n = 12) of these apps identified through our search offer support that seems to be consistent with evidence-based principles of CBT or BA. Taking into account the nonexistence of effectiveness/efficacy studies, and the low level of adherence to the core ingredients of the CBT/BA models, the utility of these CBT/BA apps are questionable. The usability of reviewed apps is highly variable and they rarely are accompanied by explicit privacy or safety policies. Despite the growing public demand, there is a concerning lack of appropriate CBT or BA apps, especially from a clinical and legal point of view. The application of superior scientific, technological, and legal knowledge is needed to improve the development, testing, and accessibility of apps for people with depression.

Introduction

Depression is one of the most common mental health disorders [1] which often begins in adolescence and if left untreated, may persist into adulthood [2]. It ranks 4th in the global burden of disease [3] and is of significant economic cost to society[4]. Cognitive Behavioural Therapy (CBT) and Behavioural Activation (BA) are now an accepted evidence-based first-line treatment for depression [5]. Both CBT and BA have meta-analytic level of evidence in the treatment of depression[6,7]. Periodic face-to-face sessions between therapist and patient have been the most traditional medium to deliver CBT and BA. However, with population estimates of
Major Depression at 6.7% and even higher for Non-Major Depression [1], it is unlikely that this traditional approach can reach everyone.

More recent research indicates that depression can be treated successfully with CBT and BA based self-help interventions delivered over the Internet [8,9,10]. This type of therapy is suited for digital delivery as demonstrated by the fact that there are more Internet-based studies on CBT/BA than on other evidence-based models (e.g., Interpersonal Therapy or Acceptance and Commitment Therapy). There is a strong case in healthcare for addressing access to CBT or BA through the use of technology, with mobile applications (apps) being one possible means of delivery. Apps could be especially useful in early treatment of depression in young people who report high levels of smartphone device use [11].

Smartphone use is a growing phenomenon [12] and has the advantage of being accessible, mobile, and easy to operate, with decreasing cost of use. Smartphones have been used to facilitate the delivery of healthcare interventions including treatment of mental health conditions [13]. The number of apps intended to help people cope with depression is increasing rapidly, especially in the commercial marketplace [14,15]; however the development process, usability, feasibility, and efficacy of these apps developed in the commercial marketplace are rarely assessed or reported. The quality of the available apps has not been the subject of any systematic reviews, until now.

It is vital to perform a systematic review of apps for depression to identify what currently available apps are based on strong and recommended evidence models for depression. Evaluating the available apps can inform future development of effective smartphone delivered intervention for depression. The purpose of this systematic review was twofold: (1) To identify all currently-available native apps that provide information, support or treatment for depression; (2) To evaluate CBT or BA self-help (either guided or unguided) apps on their usefulness, usability, and integration and infrastructure, as recommended by Chan et al. [16]. Usefulness was determined by evaluating how accurately each CBT/BA app tapped into the core of the CBT and BA models, and by exploring whether the efficacy or effectiveness of the CBT/BA apps have been proven or not. Usability was evaluated by comparing each CBT/BA app to a list of heuristics, and integration and infrastructure was evaluated by looking whether the CBT/BA apps included a privacy policy and addressed safety issues.

The results of this review can assist care providers in choosing appropriate apps for the treatment or research of depression. The review will also identify areas for future development to effectively provide CBT or BA for depression through smartphones.

**Methods**

**Inclusion and Exclusion criteria**

We included in our review those apps that met the following inclusion criteria: (1) the app description stated that they provide treatment or support for depression as its exclusive goal; (2) the app was publically available for download within Canada at the time this review was performed (December, 2015), and consequently also fully available for evaluation by the research team; (3) the app was defined as a native app (i.e., developed for one particular mobile device and installed directly onto the device itself) compatible with smartphones. We excluded from the review those apps which specifically addressed depressed subpopulations (e.g., depressed people with diabetes, postpartum depression) because they have special health care needs that require different care. We also excluded those apps that were designed to support health care professionals working with depressed populations because these apps are addressed to a different audience. We excluded web-based/Internet-enabled apps only accessible via the

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mobile device’s Web browser because they are very challenging to identify in a systematic way. Finally, we also excluded those apps which were only available in a non-English language.

Search strategy
The apps included in this review were identified by searching both the scientific literature and commercial marketplace.

The search of the scientific literature. The following databases from health sciences and computer science were searched: IEEE, ACM Digital Library, EMBASE, PubMed (Medline), PsyclnFO, and Web of Science. A library information specialist created the database-specific search strategies by combining population-specific term (i.e., depression) and terms related to technical delivery (i.e., app, smartphone, mobile phone, cell phone, text message, iphone, and android), narrowing the results to those studies related to depression and mobile apps. Search strategy in S1 Appendix displays the strategy for retrieving relevant manuscripts from PubMed. The library information specialist did the search in November 2015. During the first level of screening, two reviewers (AH, SR) independently assessed a random selection of 15% of the titles and abstracts retrieved from search (350 electronic search results) to determine inter-rater agreement on inclusion and exclusion criteria. With substantial levels of agreement (kappa = 0.69) observed [17], the remaining titles and abstracts were screened by only one reviewer (SR). At the second level of screening, potential relevant full-text articles were reviewed and a random selection of 30% of articles (a subset of 50 articles) were independently assessed by two reviewers (AH, SR). Articles were excluded at this stage from further consideration for a number of reasons (i.e., article did not talk about depression, article did not make mention of any native app, the app mentioned in the article was not addressed to people with depression, the manuscript was not written in English). With substantial levels of agreement observed at this second level of screening (kappa = 0.85) [17], the remaining full-text articles were reviewed by only one reviewer (SR). The 53 manuscripts included at this stage mentioned a total of 253 native apps for people with depression. Two independent reviewers (SR, AH) independently evaluated whether a random selection of 50% of these 253 apps (n = 125) meet the eligibility criteria based on our inclusion/exclusion criteria. With almost perfect agreement observed at this third level of screening (kappa = 0.92) [17], the remaining apps were reviewed by only one reviewer (SR). Contact was made with corresponding authors to request access to any apps described in a manuscript where there was no information provided on public access for downloading. Discrepancies at any level of screening were resolved by consensus among reviewers. See Fig 1 for details about the screening process.

The search of the commercial marketplace. The search was restricted to apps available through the two most popular mobile phone platforms, The Canadian Apple App Store and Android Market (Google Play). The search was made in November 2015 using ‘depression’ as the search query. One reviewer (JC) searched the stores to identify all of the available apps, and two reviewers (AH, JC) independently evaluated each identified unique app for eligibility based on our inclusion/exclusion criteria. The level of agreement between both independent reviewers using the Cohen’s Kappa was 0.89. Discrepancies were resolved through discussion. See Fig 1 for further details.

Data extraction
The apps retrieved by our searches were categorized by two independent reviewers (AH, JC) according to the type(s) of support that they offered to the users. The categories, defined a priori, included: self-tracking tools, education, social support, CBT/BA treatment, state induction, diagnostic/screening tools, and miscellaneous. One app could be categorized into different...
types of self-help apps when the app included more than one type of support. All the apps included in the review were available in the app stores, regardless of where they were identified (i.e., scientific literature vs commercial market). The app description displayed in the stores and any available description provided in the manuscript was the only information used by the reviewers to base their decisions on which category each app fell into. The level of agreement between the two reviewers when categorizing the apps, using the Cohen’s kappa, was 0.92, indicating almost perfect agreement [17]. When reviewers were in disagreement, they discussed it, and came to an agreement. When an agreement could not be reached, a third reviewer was called upon (SR). For those apps that were classified as CBT/BA the following information was extracted: accessibility (i.e., iTunes, Google Play, scientific literature), cost, and indicators of popularity (i.e., for the apps identified through the Google Play store, the number of times an app has been downloaded to an android phone; for the apps identified through the Google Play store or the iTunes store, the number of users that have rated the app on a scale of 1 to 5 as well as the average satisfaction rate provided by users; although both types of information are only available when there is a large, unspecified amount of users that have rated the app).

Assessment of CBT/BA apps. Since our primary focus of attention was CBT or BA only those apps that offered this type of treatment were downloaded for full evaluation. When both a paid and free version of an app was available, the version requiring payment was purchased and used, while the free version was excluded. This was done to ensure that the most comprehensive version of the app was considered. In accordance with Chan et al [16], who have recently proposed a framework to evaluate mobile mental health apps, we evaluated each app on three dimensions using the following criteria:

Usefulness: To determine the usefulness of the apps, the validity and accuracy (does the app actually offer CBT or BA?), and effectiveness (is the app clinically effective—with demonstrated improved outcomes— for people with depression?) criteria were used. To evaluate whether the app actually offers CBT or BA, an experienced academic CBT clinician (SR) evaluated the apps for their level of fidelity to theoretical CBT and BA principles by exploring what extent the apps included the core ingredients of these models. The evaluator has extensive experience in training CBT therapists and devising CBT clinical programmes. The core ingredients for CBT and BA were derived by consulting with two academic experts and one CBT clinician, as well as reviewing the literature for CBT and BA models in the treatment of depression [18,19]. The following were considered as the core ingredients of a CBT approach for depression: 1) education about depression; 2) explanation of the model, 3) depression rating, 4) monitoring cognitions, 5) monitoring emotions, 6) monitoring physical sensations, 7) monitoring behaviours, 8) conceptualization, 9) behavioural techniques, and 10) cognitive techniques. The following were considered as the core ingredients of the various BA approaches: 1) education about depression, 2) explanation of the model, 3) depression rating, 4) activity monitoring, 5) giving each activity a rating for pleasure, 6) giving each activity a rating for mastery, 7) activity scheduling of pleasant behaviours, and 8) activity scheduling of avoided behaviours. The expert evaluated each app against each core ingredient on a 0–2 scale where 0 meant that the core ingredient was not integrated at all into the app, and 2 meant that the core ingredient was completely integrated. Table 1 displays the scoring system devised for rating of the apps against each core ingredient. For each app, a percent total score (sum of item scores/maximum possible score × 100), representing the level of adherence of the app to the theoretical principles of CBT and BA approaches, was then calculated. To evaluate the effectiveness of the apps, we cross-referenced with apps identified in the scientific literature to see whether there was any efficacy or effectiveness study on apps included in the review.

Usability: The usability of the app (can the user easily—or with minimal training—use and understand the app?) was used to evaluate this dimension. Most apps retrieved from our searches have been developed by small businesses or sole proprietors outside of academic
settings, and little information is available on the app development process or evidence of formal usability testing. For this reason, a user experience designer (MW), who regularly performs expert reviews on mobile apps and websites, where he applies heuristics and professional experience to evaluate user interfaces and suggest design improvements, evaluated the usability of the apps. He evaluated the user interface of each app using a common list of usability heuristics proposed by Nielsen & Mack [20]. The usability expert rated each app on a scale of 1 to 5 (1 = poor, 5 = excellent) against each usability heuristic (see Table 2 for the set of heuristics). A percentage total score (sum of item scores/maximum possible total score x 100) was then calculated, indicating the extent to which the user interface of the app met the usability heuristics.

Integration and infrastructure: Privacy and safety were the criteria used to evaluate this dimension. To evaluate privacy, an evaluator (SR) looked into whether the apps provided users with a privacy policy (within the apps themselves or on a website linked to the app). If a privacy policy was available the evaluator assessed the scope and the level of transparency of the policy as done by Sunyaev et al. [21]. To this end, the evaluator determined whether the policy addressed the following content categories important to users: type of information collected (e.g., operational, behavioral, sensitive), rationale for collection (i.e., app operation, personalization, secondary use), sharing of information (i.e., service provision, social interaction, third party), and users controls (i.e., supervision, notification, correction). To evaluate safety, an evaluator (SR) explored whether the apps had any mechanisms in place to handle high risk of suicidality (e.g. providing emergency contact information whenever the app detects a user is at high risk for committing suicide).

Table 1. System to grade the level of adherence to the theoretical principles of CBT and BA.

| Core features                          | Item   |
|----------------------------------------|--------|
|                                       | 0      | 1      | 2      |
| **Behavioural activation**             |        |        |        |
| Education about depression             | None   | Some   | Clear explanation |
| Explanation of the model               | None   | Some   | Clear explanation |
| Depression rating                      | None   | Some   | Formally rated (e.g., on a 0–10 scale) |
| Activity monitoring                    | None   | Some   | Formally self-monitoring (e.g., through a diary) |
| Activity monitoring: Pleasure rating   | None   | Some   | Formally rated (e.g., on a 0–10 scale) |
| Activity monitoring: Mastery rating    | None   | Some   | Formally rated (e.g., on a 0–10 scale) |
| Activity scheduling of pleasant behaviours | None   | Some   | Formally rated (e.g., on a 0–10 scale) |
| Activity scheduling of avoidancebehaviours | None   | Some   | Formally rated (e.g., on a 0–10 scale) |
| **Cognitive-behavioural treatment**   |        |        |        |
| Education about depression             | None   | Some   | Clear explanation |
| Explanation of the model               | None   | Some   | Clear explanation |
| Depression rating                      | Some   | Some   | Formally rated (e.g., on a 0–10 scale) |
| Monitoring cognitions                  | None   | Some   | Thoughts and beliefs monitored |
| Monitoring emotions                    | None   | Some   | Specific emotions monitored |
| Monitoring physical sensations         | None   | Some   | Specific physical sensations monitored |
| Monitoring behaviours                  | None   | Some   | Specific behaviours monitored |
| Conceptualization                      | None   | Some   | Elements Adequate problem formulation |
| Cognitive techniques                   | None   | Some   | Systematic use of technique |
| Behavioural techniques                 | None   | Some   | Systematic use of technique |
Analysis Plan

Basic summary statistics including counts and percentages were used to describe the characteristics of the apps. Spearman’s correlation coefficient was used to explore whether a relationship may exist between the adherence of the user interface to Nilsen’s principles of usability and adherence to the core principles underlying CBT and BA. Spearman’s correlation coefficients were also used to explore whether adherence to the core principles underlying CBT and BA and adherence to Nilsen’s principles of usability is related with any indicator of popularity and acceptability (i.e., average rating of satisfaction, number of reviews and number of downloads).

Results

Search

Our search of commercial marketplace identified a total of 310 unique apps. One hundred and four of these apps identified in the commercial marketplace meet our inclusion/exclusion

| Heuristic | Description |
|-----------|-------------|
| Visibility of system status | The system should always keep users informed about what is going on, through appropriate feedback within reasonable time. |
| Match between system and the real world | The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order. |
| User control and freedom | Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo. |
| Consistency and standards | Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions. |
| Error prevention | Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action. |
| Recognition rather than recall | Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate. |
| Flexibility and efficiency of use | Accelerators—unseen by the novice user—may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions. |
| Aesthetic and minimalist design | Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility. |
| Help users recognize, diagnose, and recover from errors | Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution. |
| Help and documentation | Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large. |

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criteria. The literature search yielded 2,789 abstracts, and 160 full text manuscripts were reviewed at the full-text level. Fifty-three out of 160 were relevant for our review because all of them mention at least one native app addressed to people for depression. Many of these manuscripts identified as relevant for our review were reports or reviews reporting on multiple apps. For example, Shen et al. [14], has recently conducted a systematic review to identify and characterize all the apps available in the app stores to support people with depression, their families and health care professionals, based on the store description. The 53 manuscripts [9,14,15,22, 23,24, 25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48, 49,50,51,52, 53,54,55, 56,57,58,59,60,61,62,63,64,65, 66,67,68,69,70,71] identified as relevant to the review made mention of a total of 48 unique apps that met our inclusion/exclusion criteria. Thirty-five of these 48 apps were also identified through our search of the commercial marketplace. See Fig 1 for a flowchart of the screening process of the apps.

**App characteristics**

Out of the total 117 apps, 36 apps (30.77%) were available on iOS only, 74 (63.25%) were available on Android only, and 7 (5.98%) were available across both platforms. The most typical type of self-help support delivered through these 117 apps was education (n = 32, 27.35%) and diagnostic/screening support (n = 30, 25.64%), followed by state induction (n = 18, 15.38%). The least typical types of self-help support delivered through these 117 apps were tracking (n = 10, 8.55%) and social support (n = 3, 2.56%). Twelve of these 117 apps (10.26%) were classified by the reviewers as delivering CBT or BA; these CBT/BA apps were identified in the description by their developers as CBT or BA apps or they seemed to offer CBT or BA based on their general description (Table 3).

**CBT/BA apps characteristics**

Five of the 12 CBT/BA apps (41.67%) were available on iOS only and 5 (41.67%) on Android only. The cost of these CBT/BA apps ranged from $0.00 to $8.99. The Depression CBT Self-Help Guide and The Mood Tools–Depression Aid were those Android apps with the highest number of downloads (i.e., between 100,000 and 500,000 downloads, and between 50,000 and 100,000, respectively) and received high user satisfaction ratings (average satisfaction rates were 4.2 and 4.3, respectively). The iPhone app that received the highest user satisfaction rating was The Depression Cure: The Free 12 Week Course app (average satisfaction rating = 4.5). However, this app was not the one that received the highest number of reviews. The iPhone apps that received the highest number of reviews were the Anti-depression and MoodTools–Depression Aid apps, both of them also available for download in the Google Play store. For further information about the characteristics of the CBT/BA apps see Table 4.

Regarding the valid and accuracy of the CBT/BA apps, the median level of adherence with the CBT principles was 15% (range = 0–75%) and the median level of adherence with the BA principles was 18.75% (range = 6.25–25%). The best apps from a theoretical perspective were Depression CBT Self-Help Guide and eCBT Mood meeting 75% and 55% of the qualifying criteria for CBT, respectively. The rest of the apps presented less than 50% of adherence for both the CBT and BA principles (see Table 5). The core ingredients of CBT most commonly included in these CBT/BA apps were: education about depression and depression ratings. The core ingredients included least often were: monitoring physical sensations, monitoring behaviors, and conceptualization. The core ingredients of BA most commonly included were: education about depression and depression ratings and the rest of the core ingredients were never completely integrated into the apps. Regarding the effectiveness of the apps, there were no
studies reported in the scientific literature that determined the benefits of any of these CBT/BA apps.

The usability heuristic evaluation found that the median level of adherence with the heuristics was 83% (range = 42–98%). The apps associated with highest usability ratings were Mood Tools–Depression Aids, Activity Diary, and Depression on Cure–The Free 12 Week Course.

Table 3. All apps for depression included in the review.

| Type of Self-Help App | Screening | Number of Apps | Total Number of apps (%) | Name of the Apps |
|-----------------------|-----------|----------------|--------------------------|------------------|
| Tracking              | Commercial Marketplace | 6 | 10 (8.55) | Depression Test, Depression Tracker and Diary, Emotion, Life Robot- Fight Depression, Mood tracker- depression, Start |
|                       | Literature | 1 | iDepression Tracker |
|                       | Both       | 3 | Depression Inventory, Depression Journal, Depression Test & Tracker |
| CBT/BA                | Commercial Marketplace | 4 | 12 (10.26) | MoodTools- Depression Aid, Overcome the Depression pro, Anti-Depression, Activity Diary |
|                       | Both       | 8 | Depression, Depression CBT Self- Help Guide, Depression Cure- The free 12 week course, iCounselor: Depression, Mood Master Anti- Depression App, Mood Sentry, Positive Activity Jackpot, eCBT Mood |
| State Induction       | Commercial marketplace | 10 | 18 (15.38) | Beat Depression Hypnosis Audio, Depression Cure Hypnosis, Depression Mood Booster, Fight Depression, From Depression to Hope, MoodSpace, Vital Tones Depression, Yoga for Depression, Yoga Helps Relieve Depression, Life Robot- Fight Depression |
|                       | Literature | 2 | Depression Relief and Mood–HappyApp, Mood Elevator & Support |
|                       | Both       | 6 | Beat Depression Hypnosis Syste, Depression Help Brainwave, Depression Inventory, Heal Depression Hypnosis, The Mindful Way Through Depression, Black Rainbow: How to Beat Depression |
| Diagnostic/ screening | Commercial Marketplace | 15 | 30 (25.64) | CESD Depression Test, Depression Diagnosis Doctor, Depression Eval Questionnaire, Depression Screening Test, Depression Test, Depression Test, Depression Test, Depression Test, Depression Test, Depression Test, Depression Test and Treatment, Depression Tracker & Diary, Depression Test Pro, Depression Test, Emotion |
|                       | Literature | 4 | Am I Depressed, Do I have Depression, Happy App, Zung |
|                       | Both       | 11 | Are You at Risk for Depression?, Depression Calculator, Depression Screening, Depression Test, Depression Test, Learn About Depression, Major Depression Checker, Sad Scale Lite, STAT Depression Screening PHQ 9, The Depression Predictor, Depression Test & Tracker |
| Education             | Commercial Marketplace | 22 | 32 (27.35) | Conquering Depression, Dealing with Depression, Dealing with Depression, Depression and How to Stop it, Depression & Psychology, Depression Definition, Depression Healing, Depression Information, Depression Management, Depression Symptoms, Depression Symptoms and Signs, Depression: An Overview, Depression: Natural Remedies, Fitness Against Depression, Help with Depression, How to get Over Depression, Physical Symptoms Depression, Reduce Depression, The Key to Happiness, Black Rainbow: How to Beat Depression, Emotion |
|                       | Literature | 3 | Beat Depression, Depression Treatment, Overcoming Depression |
|                       | Both       | 7 | Depression 101, Depression Advice, NIH Depression Information, Ten Tips to Ease Depression, The Depression Predictor, Are You at Risk for Depression?, Depression Preview |
| Social Support        | Commercial Marketplace | 2 | 3 (2.56) | Dealing with Depression, You Are Important |
|                       | Both       | 1 | Depression Test |
| Unclear/ miscellaneous | Commercial Marketplace | 22 | 28 (23.93) | A Guiding Light, Acupuncture Against Depression, Afternoon in Depression, Best Depression Quotes, Depression, dePRESSION, Depression Quotes Wallpaper, Depression Quotes Wallpaper, Depression- Acupuncture, Depressive and Sad Wallpaper, Endless Depression, Get Rid of Depression with Chinese Massage Points, Guide to Depression Self- Help, How to Beat Depression, Sad Quotes Wallpaper, Sadness and Depression Quotes, Secret of Happiness, Self-Help for Depression, MoodSpace, Life Robot- Fight Depression, Depression Management, You are Important |
|                       | Literature | 3 | Depressed, DepressPill Game for Happy, Joker |
|                       | Both       | 3 | Anti-Depression Grocery List, Depression Fighter- A Practical Christian Guide, Surviving Depression |

a The total sum of number of apps for each type of self-help app is not equal to the total number of apps identified through our searches (n = 117), since some apps have been categorized into multiple categories.

b Percentage of the total 117 apps
scoring 98%, 98%, and 92% respectively. The most frequent heuristic violations of these CBT/BA apps were: visibility of the system status, and consistency and standards. See Table 6.

Only the eCBT app and the Depression CBT Self-Help Guide app offer a privacy policy. The eCBT app has a brief privacy policy that states that the information collected in the app is only accessed by the application on the device and they do not collect any information about the user or the use of the app. The Depression CBT Self-Help Guide app’s privacy policy applies to this app in particular, but also other products of its developer (other apps and its homepage). This policy is available on the developer’s homepage but is also available to users after they have downloaded the app. Its privacy policy indicates what information is collected and for what purpose, whether this information is shared with others but it does not address users control. Five out of the 12 apps (41.66%) provide important safety information during crisis. See Table 7 for details about what information is provided and how.

No relationship was found between the level of adherence of the app to the theoretical CBT or BA model and the level of adherence with the heuristics usability (rs = -0.45, p = 0.13 and rs = 0.30, p = 0.33, respectively). Also, no relationship was found between level of adherence of the app to the theoretical models and the indicators of popularity (range = rs = -0.02, p = 0.96...
Table 5. Evaluation of the usefulness dimension.

| Usefulness Dimensions | Depression Cure-the-Free 12 Week Course | iCounselor: Depression | MoodMaster-Anti Depression App | eCBT Mood | Activity Diary | Anti-Depression | MoodTools-Depression Aid | Mood Sentry | Depression | Depression CBT Self-Help Guide | Overcome the Depression Pro | Positive Activity Jackpot | Total |
|-----------------------|----------------------------------------|------------------------|-------------------------------|-----------|---------------|-------------------|--------------------------|-------------|-----------|-----------------------------|---------------------------|------------------------|-------|
| Proven Efficacy       | ✗                                      | ✗                      | ✗                            | ✗         | ✗             | ✗                 | ✗                        | ✗           | ✗         | ✗                           | ✗                         | ✗                      |       |
| Core Ingredients of CBT | Education about depression             | 1                      | 0                            | 2          | 2             | 0                 | 2                        | 0           | 1         | 0                           | 2                         | 1                      | 0     |
|                       | Explanation of the model               | 0                      | 0                            | 0          | 2             | 0                 | 0                        | 0           | 0         | 0                           | 2                         | 0                      | 0     |
|                       | Depression rating                      | 0                      | 1                            | 1          | 1             | 1                 | 0                        | 1           | 1         | 2                           | 2                         | 0                      | 9     |
|                       | Monitoring cognitions                 | 0                      | 0                            | 0          | 2             | 0                 | 0                        | 0           | 1         | 1                           | 1                         | 1                      | 7     |
|                       | Monitoring emotions                   | 0                      | 0                            | 0          | 1             | 0                 | 0                        | 1           | 0         | 2                           | 0                         | 0                      | 4     |
|                       | Monitoring physical sensations        | 0                      | 0                            | 0          | 0             | 1                 | 0                        | 0           | 0         | 0                           | 0                         | 0                      | 1     |
|                       | Monitoring behaviors                  | 0                      | 0                            | 0          | 0             | 0                 | 0                        | 0           | 0         | 1                           | 0                         | 0                      | 1     |
|                       | Conceptualization                     | 0                      | 0                            | 0          | 1             | 0                 | 0                        | 0           | 0         | 1                           | 0                         | 0                      | 2     |
|                       | Cognitive techniques                  | 0                      | 0                            | 1          | 0             | 0                 | 1                        | 1           | 1         | 2                           | 0                         | 0                      | 6     |
|                       | Behavioral techniques                 | 1                      | 0                            | 0          | 0             | 1                 | 1                        | 1           | 1         | 1                           | 1                         | 0                      | 6     |
| Total score out of 20 (%) | 2 (10)                               | 1 (5)                  | 3 (15)                       | 11 (55)   | 0 (0)         | 5 (25)                | 2 (10)                    | 5 (25)      | 3 (15)    | 15 (75)                     | 4 (20)                    | 0 (0)                  |       |
| Core Ingredients of BA | Education about depression            | 1                      | 0                            | 2          | 2             | 0                 | 1                        | 2           | 1         | 0                           | 2                         | 1                      | 0     |
|                       | Explanation of the model              | 0                      | 0                            | 0          | 0             | 0                 | 0                        | 0           | 0         | 0                           | 0                         | 0                      | 0     |
|                       | Depression rating                     | 0                      | 1                            | 1          | 1             | 2                 | 0                        | 1           | 0         | 0                           | 2                         | 2                      | 0     |
|                       | Activity monitoring                   | 0                      | 0                            | 0          | 1             | 1                 | 0                        | 0           | 0         | 0                           | 0                         | 0                      | 2     |
|                       | Activity monitoring: Pleasure rating  | 0                      | 0                            | 0          | 1             | 0                 | 0                        | 0           | 0         | 0                           | 0                         | 0                      | 2     |
|                       | Activity monitoring: Mastetyrating     | 0                      | 0                            | 0          | 1             | 0                 | 0                        | 0           | 0         | 0                           | 0                         | 0                      | 1     |
|                       | Activity scheduling of pleasantbehaviors | 1                      | 0                            | 0          | 0             | 0                 | 0                        | 1           | 0         | 0                           | 1                         | 3                      |       |
|                       | Activity scheduling of avoidance behaviors | 1                      | 0                            | 0          | 0             | 0                 | 0                        | 0           | 0         | 0                           | 0                         | 0                      | 1     |
| Total score out of 16 (%) | 3 (18.75)                             | 1 (6.25)               | 3 (18.75)                    | 4 (25)    | 3 (18.75)    | 4 (25)               | 2 (12.5)                  | 1 (6.25)    | 1 (6.25)  | 4 (25)                      | 3 (18.75)                 | 2 (12.5)    |       |

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Systematic Review of CBT and BA Apps for Depression
Table 6. Evaluation of the usability dimension.

| Name                                      | Visibility of system status | Match between system and the real world | User control and freedom | Consistency and standards | Error prevention | Recognition rather than recall | Flexibility and efficiency of use | Aesthetic and minimalist design | Help users recognize, diagnose, and recover from errors | Help and documentation | Total score out of 50% |
|-------------------------------------------|-----------------------------|----------------------------------------|--------------------------|---------------------------|-------------------|---------------------------------|----------------------------------|---------------------------------|---------------------------------|----------------------|-------------------------|
| Depression Cure—The Free 12 Week Course   | 4                           | 5                                      | 5                        | 4                         | 5                 | 4                              | 5                                | 4                              | 5                              | 5                    | 46 (92)                 |
| iCounselor: Depression                    | 1                           | 5                                      | 3                        | 2                         | 5                 | 2                              | 2                                | 5                              | 2                              | 5                    | 30 (60)                 |
| MoodMaster Anti-Depression App            | 3                           | 5                                      | 4                        | 3                         | 5                 | 4                              | 4                                | 5                              | 4                              | 5                    | 41 (82)                 |
| eCBT Mood                                 | 2                           | 5                                      | 4                        | 2                         | 5                 | 2                              | 3                                | 5                              | 5                              | 2                    | 35 (70)                 |
| Activity Diary                            | 4                           | 5                                      | 5                        | 5                         | 5                 | 5                              | 5                                | 5                              | 5                              | 5                    | 49 (98)                 |
| Anti-depression                           | 4                           | 5                                      | 4                        | 5                         | 5                 | 5                              | 3                                | 4                              | 5                              | 4                    | 44 (88)                 |
| Mood Tools—Depression Aids                | 5                           | 5                                      | 4                        | 5                         | 5                 | 5                              | 5                                | 5                              | 5                              | 5                    | 49 (98)                 |
| Mood Sentry                               | 2                           | 4                                      | 3                        | 2                         | 1                 | 2                              | 2                                | 3                              | 1                              | 1                    | 21 (42)                 |
| Depression                                | 2                           | 5                                      | 3                        | 2                         | 5                 | 2                              | 2                                | 3                              | 5                              | 3                    | 32 (64)                 |
| Depression CBT Self-Help Guide            | 2                           | 4                                      | 4                        | 2                         | 4                 | 2                              | 3                                | 2                              | 4                              | 4                    | 31 (62)                 |
| Overcome the Depression Pro               | 5                           | 4                                      | 5                        | 3                         | 5                 | 5                              | 4                                | 2                              | 4                              | 5                    | 42 (84)                 |
| Positive Activity Jackpot                 | 5                           | 5                                      | 4                        | 4                         | 5                 | 5                              | 3                                | 2                              | 5                              | 4                    | 42 (84)                 |
| Total                                     | 39                          | 57                                     | 48                       | 39                        | 55                | 43                             | 41                               | 42                             | 54                             | 44                   |                        |

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Table 7. Evaluation of integration and infrastructure dimension.

| Name                              | Do they have privacy policy? | Scope of privacy policy | Transparency of privacy policy | Do they deal with safety? | How?                                                                                                                                 |
|-----------------------------------|------------------------------|--------------------------|-------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
|                                   |                              |                          | Type of information collected | Rationale for collection | Sharing of information | User control |                                                                                       |
| Depression Cure-the Free 12 Week Course | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| iCounselor: Depression             | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| MoodMaster- Anti Depression App    | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| eCBT Mood                         | ✓                            | Single app               | ✓                             | n/a                      | n/a                      | n/a                      | ✓                                                                                       |
| Activity Diary                    | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| Anti-Depression                   | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| MoodTools- Depression Aid          | ✓                            |                          |                              |                          |                          |                          | ✗                                                                                       |
| Mood Sentry                       | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| Depression                        | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| Depression CBT Self-Help Guide     | ✓                            | This app plus other apps created by the developer, and the homepage | ✓                             | ✓                        | ✓                        | ✓                        | x                                                                                       |
| Overcome the Depression Pro       | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |
| Positive Activity Jackpot         | ✗                            |                          |                              |                          |                          |                          | x                                                                                       |

* All the information collected is stored on the device and can only be accessed by the user. Developer does not collect/store any information about the user or the use of the app.

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Fig 1. Flowchart of the screening process.

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and $r_s = 0.57$, $p = 0.18$), or between level of adherence of the app with the heuristic usability with the indicators of popularity (range = $r_s = 0.15$, $p = 0.68$ and $r_s = 0.59$, $p = 0.07$).

**Discussion**

While there are a large number of phone apps designed to assist those with depression available through the commercial market, few of these utilize a CBT or BA approach despite these being the gold standard of first line psychological treatments [72]. The few apps that provide CBT or BA seem to be popular based on the number of downloads, with 4 out of 7 of the Android available apps achieving more than ten thousand downloads.

Chan et al. [16] have recently proposed a framework that can be used for patients and health care providers to evaluate existing mental health mobile apps and help them make informed choices about their use. Chan et al. [16] suggest evaluating apps on three broad dimensions: usefulness, usability, and integration/infrastructure. After evaluating the usefulness dimension of the CBT/BA apps taking into account the main usefulness criteria of ‘effectiveness’, we can see that there is no available information on effectiveness. The few available apps that offer CBT or BA have either not been tested or the results derived from these tests have not been reported in the scientific literature. This means that we do not have any direct evidence demonstrating the efficacy of these CBT/BA apps and consequently we do not have direct scientific proof to support their use. All the apps identified through searching the scientific literature were simply cited in reviews [14]; they were not evaluated in primary research studies. Although no data on the efficacy of these CBT/BA apps have been published, we need to acknowledge that evidence may exist outside scientific journals. Knowledge can be disseminated through grey literature. The lack of direct scientific evidence for these CBT/BA apps, however, becomes especially alarming after evaluating the validity and accuracy of the content of these apps from an expert’s point of view. Of those apps which do use CBT or BA, some apps may provide benefits by partially applying CBT or BA principles, but the majority do not come close to including the core ingredients of a CBT or BA program. The lack of fidelity to proven CBT or BA principles could hamper the efficacy of these programs.

When evaluating the usability dimension, we have seen that the usability of the available CBT/BA apps is highly variable and likely serves as a barrier to adoption and regular usage for those apps that violate a large number of heuristics. For instance, the Depression CBT Self-Help Guide app has the highest fidelity to CBT models, but the low usability score could complicate its use. There is a danger that users of these available CBT/BA apps may interpret ineffectiveness as a treatment failure, when in fact, ineffectiveness may be the result of usability problems or the inappropriate application of the CBT or BA model.

On the one hand, there doesn’t appear to be a correlation between CBT/BA model adherence and usability, which means that a good application of the clinical theoretical CBT or BA knowledge when designing the app does not imply a good use of principles of usability, and/or vice versa. On the other hand, the degree to which the apps contain these core ingredients of the CBT and BA models does not appear to be correlated with the extent to which users like the app, the number of downloads, or the number of reviews for the app. Equally, the level of usability of the CBT/BA apps does not appear to be correlated with the extent to which users like the app, the number of downloads or the number of reviews for the app. This finding is not surprising; previous reviews have found no relationship between the quality of the apps and consumers reviews or ratings [73,74]. Therefore, users should be careful when using the information available on the app download page to judge the app, since this information can be misleading.
When evaluating the integration and infrastructure dimension, we have seen that safety information is not always available in apps, and very rarely are users provided with a privacy policy. This lack of availability of privacy information seems to be an issue for mental health apps in general [21]. Research has shown that privacy is a concern for many health care professionals and patients [75] and this concern is a reason for them to decline the use information technology [75,76,77] as part of their care.

We have identified through our systematic review four apps in English that offer CBT or BA treatment for depression and have been studied by researchers and published in scientific papers, the Behavioural Activation Scheduling [50], the Get Happy Program [40], CBT Mobilwork [65] and Mobilyze [45]. However, these four apps have not been included in our full analysis because they are not currently available for download by the public, at least from within Canada. The lack of empirically tested apps identified during this review is consistent with observations in other health fields [36] and raises concerns about relying on these tools to support treatment for depression. We therefore launch a call for scientists and/or app developers interested in the opportunities that mobile communication technology offers in terms of improving access to mental health care to test the existing best apps and determine from the outset how to best implement and sustain the apps over time given that technology is evolving rapidly. It is also important when designing new CBT/BA apps to try to integrate the core ingredients of these theoretical models, and to address the heuristics in order to optimize clinical benefits and make the app more usable. Finally, it is important that scientists and developers are more transparent about legal and regulatory aspects of the apps related to privacy issues (e.g., [78]). Failure to effectively plan for sustainable dissemination of apps as well as the lack of consideration of legal aspects may present significant barriers for using apps.

This review is not without limitations. First, this review was limited to English downloadable apps in Canada and only looked at the two most popular platforms when exploring the commercial market. Different apps may be available on less prevalent platforms or in other languages and/or countries, and in fact we excluded apps developed and tested in the academic setting for these reasons[9,40]. Second, the evaluation of the CBT and BA apps was based on the opinion of one expert. Although expert opinion plays an important role when no research evidence exists, the use of an expert panel instead of only one expert could have increased the credibility of the conclusions. Finally, although it was not the primary goal of this review, the lack of common constructs, outcome measures, definitions and/or standards for tracking, state induction, diagnostic/screening, and education apps make cross-case comparison of these different types of self-help apps impossible.

In summary, given the prevalence of depression [1] and the known effectiveness of CBT and BA in addressing this mental health condition [6,7], a mobile app based on clinical best practice, that meets the most basic usability standards, that is evaluated scientifically, has a privacy policy, and deals with safety matters has the potential to remove barriers to care and alleviate suffering for a large number of people with depression at a modest cost. Therefore, efforts towards achieving this are necessary.

Supporting Information

S1 PRISMA Checklist. PRISMA 2009 Checklist.
(DOCX)

S1 Appendix. Search strategy used for Pubmed.
(DOCX)
Author Contributions
Conceived and designed the experiments: AH SR (second author) PJM. Performed the experiments: AH SR (seventh author) MW LW JC SR (second author). Analyzed the data: AH SR (seventh author) MW LW JC SR (second author). Wrote the paper: AH.

References
1. Kessler RC, Chiu WT, Demler O, Waters EE. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry. 2005; 62: 617–27. PMID: 15939839
2. Kessler RC, Avenevoli S, Merikangas KR. Mood disorders in children and adolescents: an epidemiologic perspective. Biol Psychiatry. 2001; 49: 1002–1014. PMID: 11430842
3. Mathers C, Boerma T, Ma Fa D. The Global Burden of Disease: 2004 Update. 2008. Available:http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf
4. Kessler RC. The costs of depression. Psychiatr Clin North Am. 2012; 35: 1–14. doi:10.1016/j.psc.2011.11.005 PMID: 22370487
5. National Collaborating Centre for Mental Health. Depression: The treatment and management of depression in adults. 2010. Available:https://www.nice.org.uk/guidance/cg90/evidence/cg90-depression-in-adults-full-guidance2
6. Cuijpers P, Van Straten A, Warmerdam L. Behavioral activation treatments of depression: a meta-analysis. Clin Psychol Rev. 2007; 27: 318–26. PMID: 17184887
7. Butler AC, Chapman JE, Forman EM, Beck AT. The empirical status of cognitive-behavioral therapy: A review of meta-analyses. Clin Psychol Rev. 2006; 26: 17–31. PMID: 16199119
8. Van’t Hof E, Cuijpers P, Stein DJ. Self-help and Internet-guided interventions in depression and anxiety disorders: a systematic review of meta-analyses. CNS Spectr. 2009; 14: 34–40.
9. Ly K, Truschel A, Jarl M, Magnusson S, Windahl T, Johansson R, et al. Behavioural activation versus mindfulness-based guided self-help treatment administered through a smartphone application: A randomised controlled trial. BMJ Open. 2014; 4: e003440 doi:10.1136/bmjopen-2013-003440 PMID: 24413342
10. Moss K, Scogin F, Di Napoli E, Presnell A. A self-help behavioral activation treatment for geriatric depressive symptoms. Aging Ment Health. 2012; 16: 625–35. doi: 10.1080/13607863.2011.651435 PMID: 22304676
11. Irvine M. Report: More youth use smartphones as route to Web. 2013 March 13 [cited 6 September, 2014] The Big Story. [Internet]. Chicago: AP News-. [about 4 screens]. Available:http://bigstory.ap.org/article/report-more-youth-use-smartphones-route-web.
12. International Data Corporation. Smartphones Expected to Grow 32.7% in 2013 Fueled By Declining Prices and Strong Emerging Market Demand, According to IDC. 2013 June 4 [cited 6 September, 2014] IDC. [Internet]. Massachusetts: Business Wire-. [about 3 screens]. Available:http://www.idc.com/getdoc.jsp?containerId=prUS24143513.
13. Michael S. Application of smartphone technology in the management and treatment of mental illnesses. MPH. Thesis, University of Pittsburgh. 2011. Available: http://d-scholarship.pitt.edu/6783/
14. Shen N, Levitan M, Johnson A, Bender J, Hamilton-Page M, Jadad A, et al. Finding a depression App: A review and content analysis of the depression app marketplace. J Med Internet Res. 2015; 3: e16
15. Torous J, Powell AC. Current research trends in the use of smartphone applications for mood disorders. Internet Interv. 2015; 2: 169–173.
16. Chan S, Torous J, Hinton L, Yellowlees P. Towards a framework for evaluating mobile mental health apps. Telemed J E Health 2015; 12: 1038–41.
17. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977; 33: 159–174 PMID: 843571
18. Kanter JW, Manos RC, Bowe WM, Baruch DE, Busch AM., Rusch LC. What is behavioral activation? A review of the empirical literature. Clin Psychol Rev. 2010; 30: 608–20. PMID: 20677369
19. Beck AT. The current state of cognitive therapy: a 40-year retrospective. Arch Gen Psychiatry. 2005; 62 (9):953–9. PMID: 16143727
20. Nielsen J, Mack RL. Usability inspection methods: Heuristic evaluation. New York: John Wiley & Sons; 1994.
21. Sunyaev A, Dehling T, Taylor PL, Mandl KD. Availability and quality of mobile mental health app privacy policies. J Am Med Inform Assoc. 2015; 22(1):e28–33. doi: 10.1136/amiajnl-2013-002605 PMID: 25147247

22. Torous J, Staples P, Shanahan M, Lin C, Peck P, Keshavan M, et al. Utilizing a Personal Smartphone Custom App to Assess the Patient Health Questionnaire-9 (PHQ-9) Depressive Symptoms in Patients With Major Depressive Disorder. J Med Internet Res. 2015; 21(2): e18. doi: 10.2196/jmir.3889

23. Gordon M, Henderson R, Homes JH, Wolters MK, Bennett IM. SPIRIT (Stress in Pregnancy: Improving T重担). J Med Internet Res. 2015; 17(1): e11033. doi: 10.2196/jmir.11033

24. Juengst SB, Graham KM, Pulantara IW, McCue M, Whyte EM, Dicianno BE, et al. Pilot feasibility of an mHealth system for conducting ecological momentary assessment of mood-related symptoms following traumatic brain injury. Brain Inj. 2015; 29(11): p. 1351–61. doi: 10.3109/02699052.2015.1045031

25. Roepke AM, Jafee SR, Riffle OM, McGonigal J, Broome R, Mawell B. Randomized Controlled Trial of SuperBetter, a Smartphone-Based/Internet-Based Self-Help Tool to Reduce Depressive Symptoms. Games Health J. 2015; 4(3): p. 235–46. doi: 10.1089/ghj.2014.0046 PMID: 26182069

26. Watanabe N, Horikoshi M, Yamada M, Shimodera S, Akechi T, Miki K, et al. Adding smartphone-based cognitive-behavior therapy to pharmacotherapy for major depression (FLATT project): study protocol for a randomized controlled trial. Trials. 2015; 16:293. doi: 10.1186/s13063-015-0805-2 PMID: 26149441

27. Aboujaoude E, Salame W, Naim L. Telemental health: A status update. World Psychiatry. 2015; 14(2): p. 223–30. doi: 10.1002/wps.20218 PMID: 26043340

28. Ly KH, Topoco N, Cederlund H, Wallin A, Bergström J, Molander O, et al. Smartphone-Supported versus Full Behavioural Activation for Depression: A Randomised Controlled Trial. PLoS One. 2015; 10(5): p. e0126559. doi: 10.1371/journal.pone.0126559 PMID: 26010890

29. Bitsch JA, Ramos R, Ix T, Ferrer-Cheng PG, Wehrle K. Psychologist in a pocket: towards depression screening on mobile phones. Stud Health Technol Inform. 2015; 211: p. 153–9. PMID: 25980862

30. Jiménez-Serrano S, Tortajada S, García-Gómez JM. A Mobile Health Application to Predict Postpartum Depression Based on Machine Learning. Telemed J E Health. 21(7): p. 567–74. doi: 10.1089/tmj.2014.0113 PMID: 25734829

31. Bush NE, Ouellette G, Kinn J. Utility of the T2 Mood Tracker mobile application among army warrior transition unit service members. Mil Med. 2014; 179(12): p. 1453–7. doi: 10.7205/MILMED-D-14-00271 PMID: 25469967

32. BinDhim NF, Shamam AM, Trevena L, Basyouni MH, Pont LG, Alhawassi TM. Depression screening via a smartphone app: cross-country user characteristics and feasibility. J Med Internet Res. 2014; 15(11): p. e244. doi: 10.1136/amiajnl-2014-002840 PMID: 25326595

33. Clarke J, Proudfoot J, Birch MR, Whitten AE, Parker G, Manicavasagar V, Harrison V, Christensen H, Hadzi-Pavlovic D. Effects of mental health self-efficacy on outcomes of a mobile phone and web intervention for mild-to-moderate depression, anxiety and stress: secondary analysis of a randomised controlled trial. BMC Psychiatry. 2014; 14:272.(doi): p. doi: 10.1186/1471-244X-14-272 PMID: 25252853

34. Lee MD, Kang X, Hanrahan N. Addressing Cultural Contexts in the Management of Stress via Narrative and Mobile Technology. Stud Health Technol Inform. 2014; 199: p. 173–7. PMID: 24875715

35. Elias BL, Fogger SA, McGuinness TM, D’Alessandro KR. Mobile apps for psychiatric nurses. J Psychosoc Nurs Ment Health Serv. 2014; 52(4): p. 42–7. doi: 10.3928/02793695-20131228-07 PMID: 24305909

36. Donker T, Petrie J, Proudfoot J, Clarke J, Birch MR, Christensen H. Smartphones for smarter delivery of mental health programs: a systematic review. J Med Internet Res. 2013; 15(11): p. e247. doi: 10.2196/jmir.2791 PMID: 24240579

37. Proudfoot J, Clarke J, Birch MR, Whitten AE, Parker G, Manicavasagar V, et al. Impact of a mobile phone and web program on symptom and functional outcomes for people with mild-to-moderate depression, anxiety and stress: a randomised controlled trial. BMC Psychiatry. 2013; 13:312. doi: 10.1186/1471-244X-13-312 PMID: 24237617

38. Schaffer A, Kreindler D, Reis C, Levitt AJ. Use of mental health telemetry to enhance identification and predictive value of early changes during augmentation treatment of major depression. J Clin Psychopharmacol. 2013; 33(6): p. 775–81. doi: 10.1097/JCP.0b013e31829e8359 PMID: 24100787

39. Martinez-Pérez B, de la Torre-Diez I, López-Coronado M. Mobile health applications for the most prevalent conditions by the World Health Organization: review and analysis. J Med Internet Res. 2013; 15(6): p. e120. doi: 10.2196/jmir.2600 PMID: 23770578
40. Watts S, Mackenzie A, Thomas C, Griskaitis A, Mewton L, Williams A, Andrews G. CBT for depression: a pilot RCT comparing mobile phone vs. computer. BMC Psychiatry. 2013; 13:49. doi: 10.1186/1471-244X-13-49. PMID: 23391304

41. Kauer SD, Reid SC, Crooke AH, Khor A, Hearps SJ, Jorm AF, et al. Self-monitoring using mobile phones in the early stages of adolescent depression: randomized controlled trial. J Med Internet Res. 2012; 14(3): p. e67. doi: 10.2196/jmir.1858. PMID: 22732135

42. Ly KH, Carlbring P, Andersson G. Behavioral activation-based guided self-help treatment administered through a smartphone application: study protocol for a randomized controlled trial. Trials. 2012; 13:62. doi: 10.1186/1745-6215-13-62

43. Reid SC, Kauer SD, Hearps SJ, Crooke AHD, Khor AS, Sanci LA, et al. A mobile phone application for the assessment and management of youth mental health problems in primary care: a randomised controlled trial. BMC Fam Pract. 2013; 14(3): p. e129. doi: 10.1186/1471-2296-13-121

44. Harrison V, Proudfoot J, Wee PP, Parker G, Pavlovic DH, Manicavasagar V. Mobile mental health: review of the emerging field and proof of concept study. J Ment Health. 2011; 20(6): p. 509–24. doi: 10.3109/09638237.2011.608746

45. Burns MN, Begale M, Duffecy J, Gergle D, Karr CJ, Giangrande E, Mohr DC. Harnessing context sensing to develop a mobile intervention for depression. J Med Internet Res. 2011; 13(3): p. e55. doi: 10.2196/jmir.1838. PMID: 21840837

46. Giridher T, Wasilewska A, Wong, JL, Rekhi KS. Global mobile applications for monitoring health. In Computer Science and Information Technology (IMCSIT), Proceedings of the 2010 International Multi-conference on.

47. Parish C. Mental Health Library apps. Nursing standard (Royal College of Nursing (Great Britain): 1987). 29(31): p. 33–33.

48. Karasouli E, Adams A. Assessing the evidence for e-Resources for mental health self-management: A Systematic literature review. JMIR mental health. 1(1): p. e3–e3. doi: 10.2196/mental.3708. PMID: 26543903

49. Wan J, Hu B, Moore P, Ashford R. Intelligent mobile computing to assist in the treatment of depression. 2008 3rd International Conference on Pervasive Computing and Applications, Vols 1 and 2. 2008. 652–657.

50. Both F, Cuipers P, Hoogendoorn M, Klein M. Towards fully automated psychotherapy for adults-BAS-Behavioral Activation Scheduling via web and mobile phone. Healthinth 2010: Proceedings of the Third International Conference on Health Informatics, ed. A. Fred, J. Filipe, and H. Gamboa. 375–380.

51. Proudfoot J. The future is in our hands: The role of mobile phones in the prevention and management of mental disorders. Australian N Z J Psychiatry. 2013; 47(2): p. 111–113.

52. Reid SC, Kauer SD, Hearps SJ, Crooke AHD, Khor AS, Sanci LA, Patton GC. A mobile phone application for the assessment and management of youth mental health problems in primary care: health service outcomes from a randomised controlled trial of mobiletype. BMC family practice. 2013; 19(14): 84. doi: 10.1186/1471-2296-14-84

53. Price M, Yuen EK, Goetter EM, Herbert JD, Forman EM, Aciero R, Ruggiero KJ. mHealth: A Mechanism to Deliver More Accessible, More Effective Mental Health Care. Clinical Psychol & Psychother. 2014; 21(5): p. 427–436.

54. Reyes-Portillo JA, Mufson L, Greenhill LL, Gould MS, Fisher PW, Tarlow N, Rynn MA. Web-based interventions for youth internalizing problems: A Systematic Review. Journal of the American Academy of Child and Adolescent Psychiatry. 2014; 53(12): p. 1254–1270. doi: 10.1016/j.jaac.2014.09.005. PMID: 25457924

55. Gravenhorst F, Muaremi A, Bardram J, Grunerbl A, Mayora O, Wurzer G, Frost M, et al. Mobile phones as medical devices in mental disorder treatment: an overview. Personal and Ubiquitous Computing. 2015; 19(2): p. 335–353.

56. Ben-Zeev D, Schueller SM, Begale M, Duffecy J, Kane JM, Mohr DC. Strategies for mHealth Research: Lessons from 3 Mobile Intervention Studies. Adm Policy Ment Health. 2015; 42(2): p. 157–167. doi: 10.1007/s10488-014-0556-2. PMID: 24824311

57. Aguilera A. Digital technology and mental health interventions: Opportunities and challenges. Arbor. 2015:4191(771): a210. doi: 10.3989/arbor.2015.771n1012

58. Clough BA, Casey LM. The smart therapist: A look to the future of smartphones and mHealth technologies in psychotherapy. Professional Psychology-Research and Practice. 2015; 46(3): p. 147–153.

59. Torous J, Staples P, Omnell J. Realizing the Potential of Mobile Mental Health: New Methods for New Data in Psychiatry. Curr Psychiatry Rep. 2015; 17(8):602. doi: 10.1007/s11920-015-0602-0. PMID: 26073363
60. Saeb S, Zhang M, Karr CJ, Schueller SM, Corden ME, Kording KP, Mohr DC. Mobile phone sensor correlates of depressive symptom severity in daily-life behavior: An exploratory study. J Med Internet Res. 2015; 17(7):e175. doi: 10.2196/jmir.4273 PMID: 26180009

61. Warmerdam L, Riper H, Klein M, van den Ven P, Rocha A, Ricardo Henriques M, et al. Innovative ICT solutions to improve treatment outcomes for depression: The ICT4Depression project. Stud Health Technol Inform. 2012; 181:339–43. PMID: 2294884

62. Rozbroj T, Lyons A, Pitts M, Mitchell A, Christensen H. Assessing the applicability of e-therapies for depression, anxiety, and other mood disorders among lesbians and gay men: Analysis of 24 web- and mobile phone-based self-help interventions. J Med Internet Res. 2014; 16(7): p. 144–154.

63. Ben-Zeev D, Scherer EA, Wang R, Xie H, Campbell AT. Next-generation psychiatric assessment: Using smartphone sensors to monitor behavior and mental health. Psychiatr Rehabil J. 2015; 38(3): p. 218–226. doi: 10.1037/prj0000130 PMID: 25844912

64. Kauer S, Reid S, Crooke A, Khor A, Patton G, Jorm A, Jackson H. Emotional self-awareness: Preliminary analyses of a RCT using a cellular phone self-monitoring program (mobilityte) to decrease early symptoms of depression. Journal of Adolescent Health. 2011; 48(2): p. S91–S92.

65. Callan J.A., et al., CBT mobilework: A technological solution to improve depression outcomes. Clinical and Translational Science. 4(2): p. 120.

66. Murugan M. Mobile phone based supportive patient care. Indian Journal of Psychiatry. 55; p. S72.

67. Dijk SV, Voshaar RO. Black-Box: Snapshots of daily life time series analysis in a depressed elderly patient. American Journal of Geriatric Psychiatry. 2014; 22(3): p. S57.

68. Carmi L, Zohar J. Secondary prevention in depression, bipolar and addiction via mobile phone. European Neuropsychopharmacology. 2014; 24; p. S734–S735.

69. Bowman MA, Neale NV. Focus on clinical practice: Improving the quality of care. Journal of the American Board of Family Medicine. 25(3): p. 263–265. doi: 10.3122/jabfm.2012.03.120068 PMID: 22570385

70. Javelot H, Spadazzi A, Weiner L, Garcia S, Gentili C, Kosel M, Bertschy G. Telemonitoring with respect to mood disorders and information and communication technologies: Overview and presentation of the PSYCHE project. BioMed Research International Article ID 104658, 12 pages http://dx.doi.org/10.1155/2014/104658

71. Ly KH, Janni E, Wrede R, Sedem M, Donker T, Carlbring P, Andersson G. Experiences of a guided smartphone-based behavioral activation therapy for depression: A qualitative study. Internet Interventions. 2015; 2(1): p. 60–68.

72. National Institute for Clinical Excellence. Depression: management of depression in primary and secondary care. Clinical Guideline 23. 2004. http://www.scamfyc.org/documentos/depresion%20NICE.pdf (accessed 16 June 2015)

73. BinDhim NF, Hawkey A, Trevena L. A systematic review of quality assessment methods for smartphone health apps. 2015 Feb; 21(2):97–104. doi: 10.1089/tmj.2014.0088 PMID: 25469795

74. Kuehnhausen M, Frost VS. Trusting smartphone apps? To install or not to install, that is the question. Cognitive Methods in Situation Awareness and Decision Support; IEEE International Multi-Disciplinary Conference; 2013 Feb 25–28; San Diego, CA, USA. IEEE; 2013. pp. 30–37.

75. Dimitropoulos L, Patel V, Scheffler SA, Posnack S. Public attitudes in health information exchange: Perceived benefits and concerns. Am J Manag Care. 2011; 17(12 Spec No.):SP111–6. PMID: 22216769

76. Dunnebeil S, Sunyaev A, Blohm I, Leimeister JM, Kromar H. Determinants of physicians technology acceptance for e-health in ambulatory care. Int J Med Inform. 2012; 81(11):746–60. doi: 10.1016/j.ijmedinf.2012.02.002 PMID: 22397989

77. Agaku IT, Adisa AO, Ayo-Yusuf OA, Connolly GN. Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers. J Am Med Inform Assoc. 2014; 21(2):374–8. doi: 10.1136/amiajnl-2013-002079 PMID: 23975624

78. U.S. Food and Drug Administration. Guidance for industry and food and drug administration staff: mobile medical applications. 2013. Available: http://www.fda.gov/downloads/MedicalDevices/…/UCM263366.pdf on.