

The Current State of mHealth Applications for the Treatment of Depression

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CERTIFICATE OF APPROVAL

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This is to certify that the Master's Capstone Project of

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*"The Current State of mHealth Applications for the Treatment of Depression"*

Has been approved

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## **Introduction**

Smartphones and other mobile devices have revolutionized society. Around the globe, we are better able to communicate, access and share information, wherever we travel. The development of applications for these devices has allowed us to perform banking and monetary transactions, to call a ride, and to interact with our friends, families, and acquaintances, among many other activities, even when we are on the move.

In healthcare, mobile health technologies (mHealth) have emerged to allow patients to communicate with physicians and other caregivers to check in and monitor conditions and progress remotely. While mHealth practices began well before the era of the smartphone, the field has truly taken off since. Public interest in the use of mobile devices for healthcare, whether in terms of interventions, monitoring, medication reminders, or self-management, has blossomed, with a broad majority of respondents to surveys indicating that they would like mobile devices to be incorporated into care.<sup>1</sup>

Although a number of mHealth applications have been designed, tested, and implemented into medical practice, anybody can design, develop, and publish an app to an online marketplace and call it a health-related app.<sup>2</sup> The vast majority of applications billed as health apps are not designed by medical professionals and provide little to no evidence that they are based in clinical theory and research.<sup>1</sup> As such, it is difficult to assess the efficacy of an app or its basis in the clinical literature from the description listed in the marketplace.

This is especially true of apps purporting to assist in mental health. There are a multitude of apps that claim to assist in the management and monitoring of anxious and depressive symptoms in particular.<sup>3,4</sup> These conditions are particularly popular for app developers to focus on, as a majority of people experience some symptoms of these conditions at varying points in their lives at some degree of intensity.<sup>2</sup> As such, applications to address these conditions are very common and can be an easy sell on the marketplaces due to their topicality and widespread appeal.

The purpose of this review is to assess the overall state of publicly available mHealth apps that claim to treat depression. This will be done by reviewing systematic reviews published after December of 2015, in follow-up to a systematic review published by Huguet et al. (2016).<sup>3</sup> The apps discussed in this review were chosen as examples of noteworthy apps, and an application's inclusion in this study is not an endorsement of the application, but rather a result of its review by a previous study. By reviewing previous systematic reviews, this study will highlight research gaps in the literature and identify methods by which the overall efficacy, usability, and sustained use of publicly available applications for the treatment of depression could be improved.

## **Methods**

For the purpose of this review, only systematic reviews assessing one or more mobile applications pertaining to the treatment or monitoring of depression and which were published in peer-reviewed journals after December of 2015 were included. Far fewer reviews exist for smartphone-based treatment of depression

than for web-based mHealth therapies, so app-based interventions were the focus of this review.

The following databases were reviewed for peer-reviewed systematic review studies of app-based interventions for depression: PubMed, MEDLINE, PsycInfo, Scopus, The Cochrane Controlled Register of Trials, and Google Scholar. These sources were reviewed for combinations of the following search terms: “depression” “mHealth” “application” “mobile health” “mental health app” “systematic review” “Major Depressive Disorder” “marketplace” “iTunes” and “Google Play”.

Of the articles found in these searches, a title and citation search was performed to screen out non-review articles, articles that were not published in peer-reviewed journals, articles that were not available in English, articles for which full text could not be obtained, and articles that were published prior to or during December of 2015. Following this, 16 abstracts and the text of the remaining articles were reviewed, and 10 articles that did not incorporate app-based interventions for depression in their analyses were excluded. The remaining 6 systematic review articles were reviewed and described.

Risk of bias was assessed according to the Cochrane Collaboration’s tool for assessing risk of bias,<sup>5</sup> as well as by reviewing the examined articles’ own assessments of risk of bias and their methodologies.

## **Results**

The six studies reviewed were systematic reviews focusing on the treatment of depression via mHealth apps. The applications included in the table were included because they serve as a representative, but not exhaustive, sampling of

applications publicly available and which pertain to the treatment or management of depression.

The six systematic reviews are presented on Table 1 (see appendix), and are discussed below:

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*Van Ameringen, Turna, Khaledi, Pullia, & Patterson (2017)*

Van Ameringen et al. (2017) conducted a comprehensive review of mHealth literature for anxiety, mood, and related disorders, including depression. Their work reviewed 5 studies of apps that were relevant to depression, including a total of 5 applications that help patients to self-manage their depressive symptoms.<sup>2</sup> The authors found that only one of the reviewed studies had evaluated the effectiveness of mHealth interventions as compared to other interventions. The app in question, Project: EVO, identifies personal styles and provides a personalized planner for promoting activities to counter depressive symptoms. The study authors found that this app had only been significantly more effective than the control therapy in reducing the symptoms of mild depression.<sup>2</sup>

In general, the authors' review indicates that mHealth applications show promising results for relieving and documenting depressive symptoms. The authors reported that monitoring apps for depression, which allow users to report symptoms to their device and/or used an algorithm and the device's built-in sensors to predict depressive symptoms, demonstrated utility in charting high levels of PHQ-9 scores in the patient report model and were able to predict depressive symptoms with 65-86% accuracy.<sup>2</sup> However, the authors also report that these application modalities are best used in conjunction with other therapies, as poor

adherence was reported in the absence of incentives or reinforcement.<sup>2</sup> The authors report that a lack of use data among the majority of mHealth applications limits the reliability of user reports and passive outcome reporting. Together with poor adherence, this reflects the primary limitation of this study's source material.

The authors of this study did not perform a risk of bias assessment.<sup>2</sup>

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*Firth, Torous, Nicholas, Carney, Pratap, Rosenbaum, & Sarris (2017)*

Firth et al. (2017) assessed 18 studies and 22 apps concerning the treatment of depression. The studies assessed had durations of 4 to 24 weeks, included a wide range of participants, and utilized a range of outcome measures, including PHQ-9 assessments. The authors reported that app effectiveness reporting was more reliable when based upon in-app feedback, such as summary statistics and progress scores, than when based on user reporting.<sup>6</sup> The authors found that cognitive training (CT) applications produced smaller effect sizes when used for the treatment of depression than for other conditions, such as anxiety, and that Cognitive Behavioral Therapy-based and mood-management apps did not generate larger effect sizes than traditional, in-person treatment methods. Overall, they assess that smartphone interventions have a moderately positive effect on depressive symptoms.<sup>6</sup>

The authors identified the primary risk of bias for smartphone interventions as inadequate blinding of participants, with only 5 of 18 studies using intervention-matched comparators to prevent participants from identifying treatment or control status or of predicted outcomes.<sup>6</sup> They also assessed their risk of publication bias, and identified no present risk.<sup>6</sup> Although the authors identified the databases they

searched and the number of studies found, excluded, and included, they do not provide the terms used in their search.

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*Fleming, Bavin, Lucassen, Stasiak, Hopkins, & Merry (2018)*

Fleming et al. (2018) evaluated unguided self-help digital interventions for depression, anxiety, and mood enhancement, including eleven studies and two apps related to the treatment of depression. Their primary findings indicate that there is a lack of evidentiary support for the efficacy of mHealth applications for depression in real-world settings, in the absence of clinical guidance or other therapy.<sup>4</sup> The authors cited generally poor adherence to using the apps, reporting users completed a minimal number of exercises when compared to exercise completion in trial settings. They highlight the extreme variance in initial use as measured by download rates and the indicators of ongoing use as evidence supporting the need for better usage reporting measures in apps.<sup>4</sup>

The authors indicate that the greatest risk of bias they encountered was of publication bias, as intervention studies that obtained poor results were less likely to be published.<sup>4</sup> The authors describe their search strategies in great detail, including databases queried, search terms used, and inclusion/exclusion criteria.

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*Huguet, Rao, McGrath, Wozney, Wheaton, Conroy, & Rozario (2016)*

Huguet et al. (2016) identified and assessed apps based on strong evidence for efficacy in the treatment of depression. They reviewed 53 studies and 117 apps, 12 of which utilized Cognitive Behavioral Therapy (CBT) or Behavioral Adjustment (BA). They found that the degree of adherence to these therapies was generally poor and seldom included core components of these therapies, but that a lack of



adherence did not correlate to user satisfaction with the app, to the number of downloads, or to the number of reviews made on the marketplace.<sup>3</sup> The authors also found little primary research into the effectiveness of BA- and CBT-based apps, and concluded that due to poor adherence what evidence that has been published requires further study and replication.<sup>3</sup>

The authors of this study left the evaluation of BA and CBT adherence to a single expert, rather than using an expert panel. This raises the risk of detection bias, as only one person performed the assessment and may have missed details that a group of experts may have caught. The authors clearly described their search of the scientific literature and of app marketplaces, including inclusion/exclusion criteria, review policies of potential studies to include, and example search terms.<sup>3</sup>

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*Stawarz, Preist, Tallon, Wiles, & Coyle (2018)*

Stawarz et al. (2018) analyzed the functionality and user opinions of CBT-based mobile apps for the treatment of depression. They found that of the 31 apps reviewed, the majority demonstrated poor adherence to CBT, and that CBT adherence did not correlate to expert involvement during app development or to marketplace app ratings.<sup>7</sup> Their findings suggest that although apps have been shown to provide benefits when used in conjunction with traditional therapies, there is little clinical evidence that the components of CBT that are included have been beneficial in and of themselves, such that further research is required.<sup>7</sup> The study also assessed user feedback to the selected apps, identifying common themes in user reporting of applications, and assessing user favorability towards specific therapeutic and presentation components of the apps. This component of the study

found that users appreciate both the CBT-based components as well as other, non-CBT features.<sup>7</sup>

The authors reviewed apps purporting to be based in CBT directly, and did not review studies of these apps, justifying this approach as allowing them to better study the way users find and use apps for treating depression and to better review a broad selection of apps.<sup>7</sup> They searched for publicly available apps on the United Kingdom versions of the Apple App Store and Google Play. The authors clearly defined their search terms and their inclusion and exclusion criteria. The primary risk of bias identified by the authors was selection bias, as apps with extreme ratings and positive reviews could have a higher likelihood of inclusion. They sought to minimize this risk through an exhaustive selection and review process prior to beginning their analysis.<sup>7</sup>

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*Zhao, Lustria, & Hendrickse (2017)*

Zhao et al. (2017) analyzed the information and communicative technology (ICT) features of psychoeducational interventions for depression delivered via smartphone apps and the internet. Of the 55 studies reviewed, only 2 pertained to mobile applications. The other 53 studies focused exclusively on web-based interventions. The results of the two app-based studies, each evaluating a single app, indicated that mobile app versions of web-based therapies were as effective as the web versions and resulted in equivalent reductions in symptoms. Both apps utilized an interactive comic strip as part of the educational component and incorporated reminder telephone calls or emails from a clinician to encourage continued adherence to the application.<sup>8</sup> One of the studies, utilizing the Get Happy Program

app, found that symptom reduction remained consistent following three-month follow up.<sup>8</sup> In their review, the authors indicated that the use of apps that incorporate multimedia and novel activities improved adherence to therapy and user satisfaction.

The authors reviewed 55 studies, two of which evaluated app-based psychoeducational interventions for reducing depressive symptoms. The authors clearly define the databases reviewed and search terms used, as well as their inclusion and inclusion criteria. The authors highlighted the difficulty in assessing the efficacy of the various programs described due to lacking documentation of some programs, but both app-based studies reviewed by the authors describe clear reduction in symptoms for the experimental (app-based therapy) groups and reflect effective study design.<sup>8</sup>

#### *Assessment of Bias*

All of the reviewed studies other than Van Ameringen et al (2017) report some degree of limitation. However, only one reported glaring limitations or biases that could seriously undermine their findings at a systemic level. Several studies reported potential limitations due to attrition, but the studies themselves also reported measures taken to reduce the likelihood that such biases significantly influenced their findings.

Of the reviewed articles, only Firth et al. (2017) explicitly addresses the biases of the reviewed studies, reviewing them according to the Cochrane Collection's Risk of Bias Tool.<sup>5,6</sup> The authors highlight a risk of publication bias,

whereby the likelihood that only significant results were published and so were used as the basis for the authors' conclusions could be elevated.

Selection bias is a potential risk for Stawarz et al. (2018), as their methodology involved directly evaluating publicly available apps from marketplaces, assessing the apps for adherence to CBT and for user favorability according to user reviews, rather than evaluating the apps' effectiveness in improving depressive symptoms.<sup>7</sup> The risk of selection bias is therefore somewhat elevated due to the possibility of including apps that received positive reviews and extreme ratings. However, the authors' practice of independently reviewing apps to potentially include and then discussing disagreements the apps' suitability under the inclusion criteria between themselves until a consensus was reached provides some control over this risk.<sup>7</sup>

Performance bias is a potential risk for Firth et al. (2017), which identified inadequate blinding in a majority of their reviewed studies, although it is uncertain whether this influenced the outcomes of those studies and how significantly if so, due to their rigorous statistical controls.<sup>6</sup> Detection bias is highlighted as potential issue by Huguet et al. (2016), as they relied on the opinion of a single expert, rather than a panel of experts, to assess app adherence to CBT and BA protocols.<sup>3</sup>

Attrition bias represents a potential risk for two of the reviewed studies. Van Ameringen et al. (2017) reported that a lack of use data for applications and generally poor adherence to app use were the primary limitations in their source material.<sup>2</sup> The risk of incomplete data for use in their review represents the possibility of attrition bias affecting the results; however, the authors do not report

poor adherence for the depression-related studies. Zhao et al. (2017) report a lack of documentation for the computer-based intervention programs assessed by the studies they reviewed, as well as problems with adherence; however, this limitation was reported for the depression-treating programs in general, not for the two app-based interventions.<sup>8</sup> Given that adherence was encouraged by ongoing telephone and/or email contacts to participants by clinicians,<sup>8</sup> attrition bias appears less likely to have affected the reviews of the app-based interventions for depression. As such, the risk of bias is unclear.

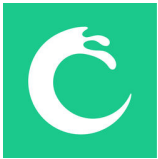

Reporting bias is a potential issue for Stawarz et al. (2018), as their review of user feedback could potentially be affected by users' tendencies to write reviews for an app only when that app is particularly good or bad; however, the algorithmic sampling of reviews and exclusive evaluation of user reviews that were in reference to one or more specific CBT-based feature of the app would help to control for polarization of user reviews.<sup>7</sup> Due to this procedural control, the risk of reporting bias is unclear, rather than high.



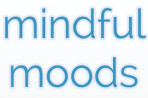


Fleming et al. (2018) faces a high risk of publication bias, identified in their review as their primary potential source of bias, which they define as the result of interventions with poor results not being reported.<sup>4</sup> The authors acknowledge that a meta-analysis could potentially have addressed this source of bias; however, this analysis was not conducted due to there being few published sources and heterogeneous data, although they note that such an analysis would be a valuable addition to the literature, and that their findings could be of use as a basis for future research.<sup>4</sup>

Zhao et al. (2017) may be limited for the purposes of this evaluation by small sample size.<sup>8</sup> Of the reviewed studies, only two examined mobile app-based interventions for depression; the remaining 53 interventions were web-based. Given that both apps were mobile versions of web-based interventions reviewed in the same systematic review and that both apps produced similar outcomes to their web-based counterparts, it is difficult to assess how effective app-based interventions are when compared to web-based versions.

*A Sample of Apps for Depression Intervention*

The following is a review of apps reviewed by previous studies, assessing their purpose, features, trustworthiness, and demonstrated health outcomes. These apps were identified from the reviewed articles as being worthy of discussion as case examples in the context of depression interventions. With one exception, all demonstrated efficacy in treatment for depression or for the monitoring of depressive symptoms.

Name	Platform	Cost	Purpose	Outcomes	Features	Trustworthiness
Depression Monitor <sup>2</sup> (Now part of Pacifica app) 	iPhone	Free	Assess severity of depressive symptoms	Assessed severity of depressive symptoms	Mobile PHQ-9 test, tracks severity of symptoms over time	Validated against paper version of PHQ-9 test
Get Happy Program <sup>2</sup> 	iPhone	Free	To increase personal happiness and wellbeing via activity and lessons	Led to significant decrease in depressive symptoms with no significant difference between app and computer versions.	Based in CBT, delivers lessons on dealing with depression via interactive comic book.	An 8-week clinical trial resulted in significantly reduced depressive symptoms, which remained stable after 3 months (P < .001)

 <p>Happify<sup>4</sup></p>	Android & iPhone	Free (paid version has extra features)	Assess user happiness and prompt activities to improve mood	Demonstrated high rate of uptake and comparatively high rate of ongoing use.	Includes elements of CBT & positive psychology, including gaming elements	No clinical evidence from previous trials to support use in treating depression; significantly high rate of short-term usage (within two weeks of registration)
 <p>Intellicare App Suite<sup>2, 4</sup> (includes BoostMe and Worry Knot apps)</p>	Android	Free	Reverse drop in mood via activity	Significantly reduced PHQ-9 scores in trial conditions.	Prompts a variety of positive activities tailored to the user when a drop in mood is reported	An 8-week clinical trial resulted in significantly reduced PHQ-9 scores ( $P < .001$ )
 <p>MindfulMoods<sup>2</sup></p>	iPhone	Free	Assess severity of depressive symptoms	Effectively severity of depressive symptoms using truncated version of PHQ-9 test.	Provides random sample of three questions from PHQ-9 test on a daily basis	Study monitored symptoms over period of 1 month. Results showed a strong correlation of effectiveness between app and paper version of PHQ-9 test ( $r = 0.84$ ).
 <p>Mobilyze<sup>2</sup></p>	Not available	N/A	Assess user mood and prompt activity	Via monitoring, app effectively reduced depressive symptoms via prompted lessons, activities, and coaching.	Mood monitoring via built-in sensors, featured website support and coaching	8-week trial ( $n = 7$ ) showed significant decrease in depressive symptoms ( $P < .001$ ).
 <p>Purple Robot<sup>2</sup></p>	Android	Free	Predict depressive symptoms via activity monitoring	Successfully identified a majority of depressive states in participant of pilot study	Mood monitoring via built-in sensors. Does not interpret mood states	Predicted depressive states with 65-86% accuracy ( $n = 28$ ), verified by PHQ-9 testing

The Depression Monitor app administers the Patient Health Questionnaire-9 (PHQ-9) test, which provides scores to assess the strength of depressive symptoms at the time of the test. This app is purely for assessment purposes, and has been verified to be as effective as the paper version of the test.<sup>2</sup> Another app that employs the PHQ-9 test is MindfulMoods, which provides the user with three randomly-

selected questions from the test each day, and which tracks the user's PHQ-9 scores over time, providing ongoing monitoring that a clinician could use when providing treatment or which a user could use for self-care.

The efficacy of the Intellicare App Suite in treating depression was validated via PHQ-9 scores,<sup>2,4</sup> as was the Purple Robot app's ability to monitor and predict depressive symptoms based on personal activities, as monitored by the smartphone's built-in sensors.<sup>2</sup>

### **Discussion**

Mobile applications intended to serve as interventions for depression have become more commonly available over the last several years. However, the pace of development has far exceeded that of the scientific literature concerning the efficacy, usability, and role of these apps. Anybody can design and publish an app to a marketplace and advertise it as health-related. As a result, the overwhelming majority of apps available on the major marketplaces that claim to be relevant for the treatment and/or management of depression have little to no basis in the clinical literature.<sup>2</sup> This lack of literary backing, and the general lack of correlation between the overall rating of apps and adherence to established methods of treatment have created an environment where it can be very difficult to trust whether an app that purports to treat or aid in the treatment of depression actually does so. This challenge is compounded by the extremely limited analyses of potential biases in the reviewed articles. Without a much more rigorous analysis and discussion of potential biases, it is difficult to confidently assess the overall state



of research into the effectiveness of mobile apps in the treatment and monitoring depression.

So far, studies of app-based interventions for depression have yielded mixed results. Some reviews have indicated that app-based interventions are best used to augment other forms of therapy.<sup>7, 8</sup> Other studies report that some apps can elicit improvement in symptoms independently of other treatment modalities.<sup>2</sup>

These best in class apps are based in clinical research and theory, and have demonstrated their validity when properly used. The Intellicare App Suite, Mobilyze!, and the Get Happy Program were shown to decrease depressive symptoms in 1-month trials.<sup>2</sup> The Mobilyze! app and the Intellicare Suite prompt activities when a drop in mood is reported, whereas the Get Happy Program uses an interactive comic strip to teach users lessons on how to manage their symptoms. These apps, and the methods they employ, can be directly used to help patients manage depressive symptoms.

Depression Monitor, the Intellicare apps, MindfulMoods, and Purple Robot were validated against paper versions of the PHQ-9 test.<sup>2,4</sup> These apps, and future developments upon them, could be effectively used in the monitoring of depressive symptoms.

Mobilyze!, and the Get Happy Program engage users with tailored activities, including games, to encourage users to continue to participate in treatment. Models of engagement like these have been well documented for their ability to attract and help users to adhere to the intervention provided by the application.<sup>8</sup> Unfortunately, apps that use these models for engagement can easily prove more attractive to users

than apps that more closely adhere to clinical guidelines. The extremely popular Happify app, for example, incorporates gaming elements, positive psychology, and elements of CBT, but has no clinical evidence to support its use in treating depression.<sup>4</sup>

The Happify app exemplifies a problem in app design for depression interventions: that engaging and fun applications can be marketed as health applications when there is no clinical bias for their use. A common problem in CBT-based apps is that only a few components of the actual therapy might be incorporated into the app in question.<sup>7</sup> As a result, apps based in CBT and other therapies commonly have extremely poor adherence to said therapies, while still being labeled according to those therapies.<sup>3</sup>

The trustworthiness of publicly available app-based interventions for depression is therefore generally suspect. Thus, it is essential that research be conducted to improve the adherence of these app-based interventions to their clinical underpinnings and to incorporate the engaging multimedia approach that encourages users' continued use.

### **Conclusion**

As research into the role and efficacy of app-based interventions for the treatment of depression continues, it will be important to establish a means of making well-designed, highly usable, and efficacious apps available and visible to smartphone owners seeking such an app. These apps will need to be easily identifiable to prospective users as having evidence to support their role in

treatment, and to provide prospective users with a clear description of how to app is to be used.

One potential solution would be the establishment of a curated collection of applications offered on the marketplaces. Such a collection could require one or more clinicians to review and evaluate whether the app has enough support in the clinical literature to warrant inclusion. This solution could allow patients to be confident that the app they use provides documented benefits in the management and treatment of depressive symptoms.

Ultimately, the primary research needs in this field are to expand the body of evidence for what app-based interventions demonstrate significant benefits; to study apps that sustain high levels of user engagement; and to assess the role of app-based depression interventions both in therapy settings and as self-help. It will be extremely important to develop a reliable means of communicating to smartphone users which apps have high efficacy and to incorporate features that foster user engagement and adherence to therapy.

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Table 1. Studies Reviewed

<b>Review Year</b>	<b>Aim</b>	<b>Search Strategy</b>	<b>No. Studies Included</b>	<b>Total No. of Apps</b>	<b>Summary of Findings</b>	<b>Summary of Health Outcomes</b>
<p>Van Ameringen, Turna, Khalesi, Pullia, &amp; Patterson<sup>2</sup></p> <p>2017</p>	<p>To provide a comprehensive review of mHealth app literature for anxiety, mood, and related disorders.</p>	<p>Used PubMed, MEDLINE, PsycINFO, and Google Scholar</p> <p>Search terms provided</p> <p>Apple iTunes and Google Play stores reviewed for popular apps.</p>	<p>5 studies on apps to treat Major Depressive Disorder</p>	<p>5 specific to Major Depressive Disorder</p>	<p>Only one study reviewed evaluated effectiveness of mHealth interventions for depressive symptoms. There is a lack of research on mental health application effectiveness. Seventy percent of mental health professionals do not utilize mHealth applications in treatment. Application use is less accepted among patients as an alternative to face-to-face treatment.</p>	<p>Many applications purport to treat mental health conditions, including depression. Two applications described improved recovery rates for Major Depressive Disorder, but only one effectively reduced symptoms. Without incentives to use the apps, studies found poor adherence to mHealth interventions.</p>
<p>Firth, Torous, Nicholas, Carney, Pratap, Rosenbaum, &amp; Sarris<sup>6</sup></p> <p>2017</p>	<p>To assess the efficacy of delivering mental health interventions via smartphones to reduce depressive symptoms</p>	<p>Used Cochrane Register of Controlled Trials, Health Technology Assessment Database, AMED, HMIC, MODLINE, Embase, PsycINFO, and Google Scholar (through May 1, 2017)</p> <p>Search terms not provided</p> <p>Limited to English-language studies</p>	<p>18</p>	<p>22</p>	<p>In-person reporting on mHealth effectiveness in treating depression unreliable, while those that did not rely on human reporting generated more significant findings. In-app feedback, such as progress scores and</p>	<p>Cognitive training apps produced smaller effect sizes for depression treatment than for mental health conditions as a whole. Use of mood-monitoring software and CBT-based applications did not elicit larger effect sizes than</p>

					summary statistics were better measures of effectiveness.	traditional treatment methods. Smartphone interventions had a moderately positive effect on depressive symptoms.
Fleming, Bavin, Lucassen, Stasiak, Hopkins, & Merry <sup>4</sup>  2018	To assess usage data of unguided self-help digital interventions for depression, anxiety, and mood enhancement.	Used Scopus, Embase, MEDLINE, and PsycINFO (through March 8, 2017)  Search terms provided.  Limited to English-language studies.	11	2 apps related to depression (1 for anxiety & depression, and 1 for anxiety, mood, & depression)	Smartphone interventions see limited adherence in real-world settings as opposed to in trial settings. The authors found that there was limited reported data on uptake, ongoing use, and effect sizes in real-world settings.	With generally poor adherence reporting, mental health outcomes from real world app-based treatments are difficult to assess compared to trial-based reporting.
Huguet, Rao, McGrath, Wozney, Wheaton, Conroy, & Rozario <sup>3</sup>  2016	To identify currently available apps that are based on strong and recommended evidence models for depression. Assessed apps according to CBT and BA models.	IEEE, ACM Digital Library, Embase, PubMed (Ledline), PsycINFO, and Web of Science (through November 2015).  Search terms provided in appendix.  Utilized Canadian Apple App Store and Android Market.	53	117  (36 iOS exclusive, 74 Android exclusive, 7 available across platforms)  12 of 117 apps delivered CBT or BA	Usability ratings of apps are highly variable and reflect barriers to adoption and implementation. Usability ratings and adherence to CBT or BA models do not correlate to whether users like the app, to the number of downloads, or to the number of reviews. There was poor median adherence to CBT and BA models.	There is a lack of primary research studies assessing the effectiveness of BA- and CBT-based apps. As such, the health outcomes of mobile apps based on these therapeutic models is unclear and requires further study.
Stawarz, Preist, Tallon, Wiles, & Coyle <sup>7</sup>	To analyze the functionality and user opinions of	UK version of Google Play and Apple App Store (through January 2017)	n/a	31	The reviewed applications generally demonstrated poor	App user reports suggest that app usage improves patients'

2018	mobile apps that use CBT to address depression.	Search terms provided.			adherence to CBT model, often including three or fewer items. CBT adherence did not correlate to expert involvement and app ratings.	experience with traditional therapy when used alongside it. Poor adherence to core components of CBT renders reports of direct benefits to health outcomes suspect.
Zhao, Lustria, & Hendrickse <sup>8</sup>  2017	To examine ICT features of psychoeducational interventions delivered via the internet or via mobile technology	CINAHL, Cochrane Library of Systematic Reviews, EBSCO, Essential Evidence Plus, Evidence-Based Medicine Reviews, Health Reference Center, PsycINFO, and PubMed. (through 2014).  Search terms provided.	55	2 apps, 53 web-exclusive major depressive disorder interventions	Higher levels of compliance correlate to greater clinician involvement in use. Mobile applications and web-based interventions are effective in increasing adherence to therapy. Multimedia and interactive features of apps and websites improved correlated to improved adherence to therapy and user satisfaction.	A combination of an app and a website in conjunction with traditional therapy significantly reduced depressive symptoms while maintaining high user satisfaction. One app using an interactive comic strip demonstrated consistent symptom improvement after 3-month follow up.