



Current research and trends in the use of smartphone applications for mood disorders



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ARTICLE INFO

Article history:

Received 29 January 2015

Received in revised form 18 March 2015

Accepted 20 March 2015

Available online 30 March 2015

Keywords:

Smartphones

Psychiatry

Depression

Bipolar disorder

Applications

Apps

ABSTRACT

Background: Smartphone applications for mental illnesses offer great potential, although the actual research base is still limited. Major depressive disorder and bipolar disorder are both common psychiatric illness for which smartphone application research has greatly expanded in the last two years. We review the literature on smartphone applications for major depressive and bipolar disorders in order to better understand the evidence base for their use, current research opportunities, and future clinical trends.

Methods: We conducted an English language review of the literature, on November 1st 2014, for smartphone applications for major depressive and bipolar disorders. Inclusion criteria included studies featuring modern smartphones running native applications with outcome data related to major depressive or bipolar disorders. Studies were organized by use of active or passive data collection and focus on diagnostic or therapeutic interventions.

Results: Our search identified 1065 studies. Ten studies on major depressive disorder and 4 on bipolar disorder were included. Nine out of 10 studies on depression related smartphone applications featured active data collection and all 4 studies on bipolar disorder featured passive data collection. Depression studies included both diagnostic and therapeutic smartphone applications, while bipolar disorder studies featured only diagnostics. No studies addressed physiological data.

Conclusions: While the research base for smartphone applications is limited, it is still informative. Numerous opportunities for further research exist, especially in the use of passive data for, major depressive disorder, validating passive data to detect mania in bipolar disorder, and exploring the use of physiological data. As interest in smartphones for psychiatry and mental health continues to expand, it is important that the research base expands to fill these gaps and provide clinically useful results.

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1. Introduction

Mood disorders remain a common but disabling condition, with a 9.5% 12-month prevalence among the U.S. adult population (Kessler et al., 2005). Two major mood disorders include major depressive disorder with a 6.9% prevalence (National Institute of Mental Health) and bipolar disorder with a 2.9% prevalence (National Institute of Mental Health). Despite the prevalence of mood disorders, only 51% of those suffering from major depressive disorder, and 49% of those with bipolar disorder, are receiving any treatment, and of those, only 21% and 19% are receiving minimally adequate care respectively (National Institute of Mental Health;

González et al., 2010). In light of both this high prevalence and unmet need, there has been recent interest in the utility of new tools, such as smartphone apps, for patients with mood disorders. A similar situation exists for nearly every psychiatric condition, with mobile mental health offered as a means to increase access to care, reduce stigma, improve diagnosis, and expand treatment modalities. Although much has been written about this potential, there is currently a sparse evidence base supporting mobile mental health's use (Powell et al., 2014). While the literature base on mobile mental health for mood disorders is small, there is value in understanding the current efforts and future trends. In this paper, we provide a review of smartphone-based app research applied towards major depressive and bipolar disorders, offer a framework for clinicians and researchers alike to classify and understand such research, and explore future trends.

While mobile mental health is a broad and evolving field, smartphones stand out as a novel tool. Integrating the abilities of a

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phone, computer, journal, Internet connection, survey platform, and a host of sophisticated sensors, smartphones have an array of features that can be applied towards mental health (Glenn and Monteith, 2014). Patients within the mental health system increasingly own smartphones and are interested in using their smartphones to monitor their health (Torous et al., 2014a,b). In only a few years, thousands of commercially available health related applications have emerged (Powell et al., 2014) and many of these are targeted towards mental health (Chan et al., 2014). While several recent content analyses of commercially available mental health applications suggest that few have been formally evaluated (Savic et al., 2013), this has not deterred patients, and a recent study in a primary care population noted that 57.2% of patients have downloaded a health-related app to their smartphone (Carras et al., 2014). Thus, between its proposed potential and current commercial applications, the reality of mobile mental health cannot be ignored.

Given the evolving and dynamic nature of mobile mental health, it can often be difficult to draw firm boundaries and definitions of technologies such as apps. Responsive webpages can load on smartphones and mimic apps only when an Internet connection is available, some apps only work in the context of larger sensor network-based interventions (e.g. a fitness tracker sending activity level to a smartphone app), and many apps discussed in the research literature are not actually commercially available. Acknowledging the inherent complexity in reviewing the literature in this rapidly progressing field of mobile mental health, we define a smartphone app as a program downloadable and saved to a smartphone that runs with or without Internet availability and utilizes the graphic and computing capabilities of the smartphone.

Understanding the mobile mental health literature can appear daunting, given the complexity of mental illness, diverse applications of new smartphone technology, lack of standardized measurements and outcomes, and finally pilot nature of much of the work. However, through understanding some basic concepts about this research, a useful framework to contextualize mobile mental health emerges. These smartphone apps can be broadly broken down into those that are active and passive. Active apps require direct participation from the patient, such as completing mood logs or recording subjective experiences. Passive apps do not require active participation of the patient, and can autonomously gather data through a smartphone's GPS, accelerometer, or other sensors. In addition, mobile mental health apps can be separated into two further distinct categories, those that mainly serve a diagnostic role by monitoring or recording symptoms versus those offering interventions such as mobile therapy or health reminders. As is shown in Table 1, a two by two matrix with mobile mental health apps that are active versus passive and diagnostic versus interventional on each axis provides a useful framework to organize and understand the current research.

Using this framework, we review the published outcomes literature on app research for major depressive and bipolar disorders with the objective of providing insight into the current state and future directions of smartphone based research for mood disorders. We hypothesize that while much of the evidence will be preliminary in nature, utilizing this framework can help elucidate current research efforts and suggest emerging trends. Understanding the current research base can also help clinicians understand what is more evidence-based versus more speculative in the use of smartphone apps for mood disorders.

2. Methods

We conducted a literature search of PubMed and Medline for relevant articles published on or before November 1st, 2014. We aimed to identify studies utilizing native smartphone apps applied for screening or clinical care for either major depressive or bipolar disorders. Our search query was restricted to the English language and included a combination of the words “bipolar”, “depression”, “depressive”, “mHealth”, “smartphone”, “mobile”, and “app” yielded 1025 results. Two studies were added by hand based on review of references. Both authors manually examined the abstracts, and if necessary the body, of each study in order to determine whether it should be included or excluded based on the below criteria. Disagreements were discussed until consensus was reached. Of these 1025 results, 430 were not directly related to mental health and were thus excluded. Of the remaining 595 studies, 509 were not directly related to bipolar disorder or major depressive disorder, or discussed mental health in broad generalized terms, and so were also excluded. We sought to only target studies featuring smartphone apps and so excluded a further 55 studies that did not feature modern smartphones in that they did not have Internet capabilities, the ability to run apps, and feature either a touch screen or QWERTY keyboard. Of the remaining 31 studies, 17 did not provide quantitative results or were protocols for potential studies, and thus were excluded. Ultimately, only 14 of the initial 1025 studies were included in the review. Consensus was initially not reached for three studies regarding final eligibility, but all three were deemed not eligible after one round of discussion between the authors.

In order to contextualize the literature, we employed the matrix outlined in the introduction. Of note, we subdivided the diagnostic categories into diagnostics related to patient symptoms, patient behavior, and physiology domains based on the National Institute of Mental Health's Research Domain project's units of analysis (Insel et al., 2010). We also subdivided smartphone-based interventions into those related to psychoeducation, medication administration, and therapy.

3. Results

3.1. Major Depressive Disorder

We identified ten studies on the role of smartphone applications for major depressive disorder (Bush et al., 2013; Bindhim et al., 2015; Pelletier et al., 2013; Webb et al., 2013; Kauer et al., 2012; Hammonds et al., 2015; Schaffer et al., 2013; Ly et al., 2014; Watts et al., 2013; Burns et al., 2011).

3.1.1. Active data for diagnostics

Apps that collect data related to validated psychiatric instruments have been a focal area for research. Four studies examined the feasibility of actively surveying patients' symptoms of major depressive disorder on a smartphone for the purpose of delivering diagnostic information. One study showed high inter-reliability of PHQ-9 data collected on paper versus an iPhone app in a population of 45 soldiers (Bush et al., 2013). Many of the other studies have focused on demonstrating the feasibility and acceptability of data collection. Feasibility studies have examined collecting PHQ-9 scores using a publicly available app (8421

Table 1
Smartphone research studies categorized by the type of app studied.
(Major depressive disorder studies are bolded; bipolar disorder studies are in italics).

	Diagnostics			Interventions		
	Patient symptoms	Patient behavior	Physiology	Psycho-education	Medication related	Therapy
Active/reported	13,14, 15, 16			17	18,19	20,21
Passive	25, 26	22				
Active and passive	23, 24					

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