



# Towards Development of a Mobile Application to Evaluate Mental Health: Systematic Literature Review

Jorge A. Solís-Galván, Sodel Vázquez-Reyes<sup>(✉)</sup>, Margarita Martínez-Fierro, Perla Velasco-Elizondo, Idalia Garza-Veloz, and Claudia Caldera-Villalobos

Universidad Autónoma de Zacatecas, Campus Siglo XXI, Carr. Zacatecas-Guadalajara Km. 6, Ejido “La Escondida”, 98160 Zacatecas, Mexico  
{36171296, vazquezs, margaritamf, pvelasco, idaliagv}@uaz.edu.mx, clau.cal.villa@gmail.com

**Abstract.** Mental disorders such as depression, anxiety, and stress are increasingly present in the lives of many people, which has led these disorders to be a latent public health problem today. This situation has prompted the development of new solutions focused on improving people’s mental health status, some of these solutions are based on mobile applications. This article presents the results of a systematic literature review that was carried out with the aim of identifying mobile applications that address the most common mental health conditions, focusing on the design, development and/or evaluation of this kind of application. 152 primary studies were selected, 86 of them reported on evaluations of mental health applications. However, 72 of the primary studies addressed more than one mental disorder, highlighting depression, stress, and anxiety.

**Keywords:** Mobile application · Mental health · Mental disorders · Depression · Anxiety · Stress · Anguish

## 1 Introduction

“Mental health is a complex phenomenon determined by multiple social, environmental, biological, and psychological factors, and includes conditions such as depression, epilepsy, dementia, anxiety, developmental disorders in childhood, and schizophrenia” [1]. The World Health Organization (WHO) predicts by 2030 that mental illness will be the main burden of disease worldwide [2].

In Mexico, the results of the National Survey of Psychiatric Epidemiology (ENEP for its initials in Spanish) indicated that approximately one in five individuals has at least one mental disorder at some point in their life [3]. Unfortunately, there is a lack of information about the use of services for mental health problems by Mexican university students, a population that according to various researches is at greater risk of suffering from a mental disorder. Although students can benefit from the health services offered

by their universities, little is known about their willingness to seek help from these services [4].

Due to the consequences of mental health conditions such as depression, which is now the world's leading cause of disability, the need for innovative solutions is evident [2]. The prevalence of mobile phone use today has enabled mobile app-based mental health interventions to become an increasingly popular approach to combat traditional barriers to accessing mental health services [5].

Due to the impact of mental health conditions on people, and some of them such as depression with the greatest impact on young people [6], the *Programa Académico de Medicina Humana de la Universidad Autónoma de Zacatecas* seeks to find out the state of mental health of the student population to identify the conditions that could be affecting students and trying to find solutions in early stages. To achieve this goal, the development of a solution based on a mobile application has been considered.

The systematic literature review aims to identify the mobile applications that have been developed in the field of mental health, in such a way that it is possible to locate the successes and mistakes made in the development of these applications, in order to use this knowledge to develop the desired solution at the *Universidad Autónoma de Zacatecas*.

## 2 Methods

For the development of this research, the three main phases of the Systematic Literature Review (SLR) were taken as the basis: planning the review, conducting the review and informing the results [7]. The following sections detail how each of the phases were executed.

### 2.1 Planning the Review

Planning is the first phase of a systematic review. Within this phase, as the first activity, the need for revision was identified.

#### 2.1.1 Identify the Need to Perform the SLR

The *Programa Académico de Medicina Humana* has factors that could influence the origin of mental health conditions in students. According to the research, the symptoms of depression and physical damage in students in the health area may be related to the excessive workload they have [8]. From these researches, it was identified the need for an auxiliary solution in the detection of mental health conditions, which should be developed from the best practices that have been used to develop tools in the field of mental health. Hence the need for this review, which aims to identify the mental health applications that have been developed, it is meant to detect the successes and mistakes that have been made.

### 2.1.2 Research Questions

For the review process, research questions were formulated, that were useful throughout the process: 1) Which existing mobile applications are currently used to treat the most common mental health-related conditions such as depression, stress, anguish, anxiety?; 2) What are the strategies that were used for the development of mobile applications focused on mental health?

### 2.1.3 Search String

The keywords that were part of the search string were extracted from the research questions. Indicating synonyms and related terms, in addition to the use of logical connectors, the search string was generated, which is shown in Table 1.

**Table 1.** Keywords and search string

Keywords	Synonyms or related words	Search string
Mobile application	Mobile App, Cellphone App, Smartphone app, App	(((mobile OR smartphone OR cellphone) AND (app OR application)) OR app OR application) AND (detection OR discovery OR location) AND ((mental AND health) OR depression OR anxiety OR anguish OR stress)
Detection	Discovery, Location	
Mental health		
Depression		
Anxiety		
Stress		
Anguish		

### 2.1.4 Data Sources Selection

As the last step of this phase, the data sources were chosen to execute the search. One of the criteria used to choose these sources was the fact that they are considered very relevant in the field of Software Engineering, and even when working in conjunction with the Health Sciences area, the aim of this review is focused on finding software solutions. Finally, the chosen sources were: 1) IEEE Xplore, 2) ACM Digital Library, 3) ScienceDirect and 4) Journal of Medical Internet Research (JMIR).

## 2.2 Conducting the Review

In the second phase of the SLR process, the primary studies are selected. This section describes the main activities that were carried out to meet the objective of the phase.

### 2.2.1 Inclusion and Exclusion Criteria

Inclusion criteria: 1) title and abstract of the study are in Spanish or English; 2) the study was published between 2010 and 2020; 3) the study has at least two keywords in the

title and abstract; and 4) the study is a review, evaluation, design or development of a mobile mental health application.

Exclusion criteria: 1) the study is not accessible; 2) it is a repeated study; and 3) does not contain information about a review, evaluation, design or development of a mobile mental health application.

### 2.2.2 Primary Studies Selection

For the selection process, 4 main steps were identified. In step number 1, the search string generated in the first phase was used, adapting it according to the conditions of each of the search engines. In step number 2, only studies whose title and abstract are in Spanish or English were selected; whose publication year is between 2010 and 2020; and those where the title and the abstract have at least two of the keywords that were previously indicated in Table 1. In step number 3, the titles and abstracts of all the studies were read to identify those that met the requested features. Finally, in the last step, the remaining criteria were applied, in some studies, it was necessary to read them completely to identify those that met all the criteria. Studies that met this last step were selected as primary studies. Figure 1 shows how the filtering of the studies was, of the 450,915 that were obtained at the beginning until reaching the 152 primary studies. Appendix A shows information from each of the primary studies. The complete references of the primary studies can be accessed at the following link: <https://bit.ly/31w0T9n>.

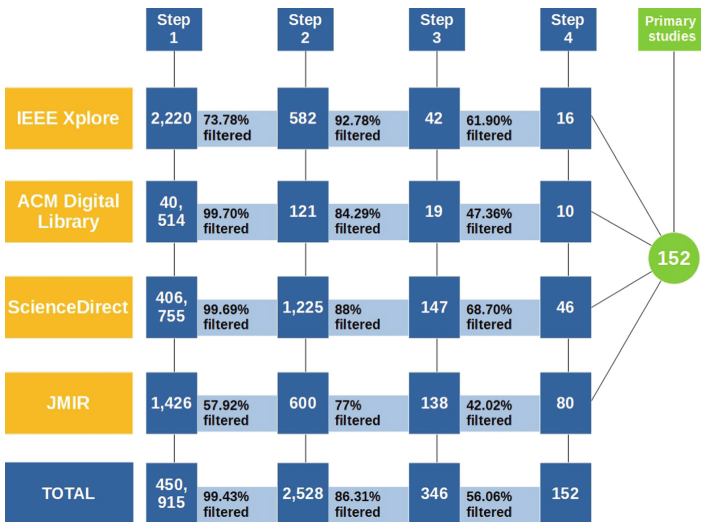


Fig. 1. Selection process of primary studies.

### 2.2.3 Data Extraction

From the studies that were selected as primary, extraction of the information from each of them was performed; a template in a text document was used as a basis, the data extracted from the studies were: title, author(s), publication year, country, keywords, data source, goal, problem, strategy, findings and summary.

## 3 Results

This section presents the analysis of the main results of the SLR.

### 3.1 Studies Selection and Inclusion

A total of 450,915 studies that were obtained in the initial search of the data sources, 448,287 were excluded after applying the first three inclusion criteria. 2,182 studies were excluded after reading the title and abstract, leaving a total of 346 studies. Finally, 194 studies were filtered, leaving a total of 152 studies that meet the inclusion and exclusion criteria, these studies represent the primary studies.

### 3.2 Primary Studies Features

The selected primary studies were published between 2012 and 2020. Figure 2 shows the distribution by year of publication of these studies, the distribution shows an increasing trend of studies related to technological solutions in the field of mental health over the years. This gives relevance to our proposal for the mobile application to assess mental health.

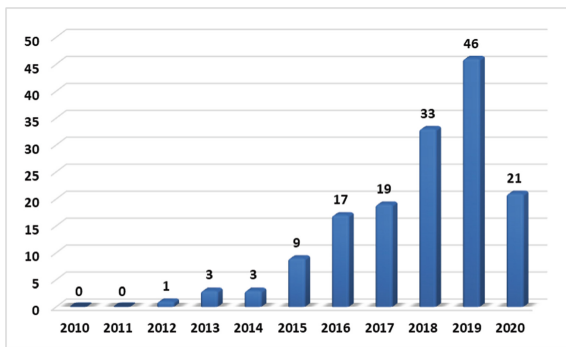


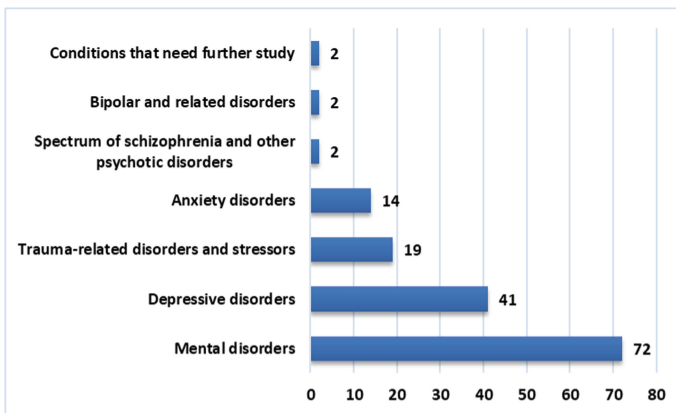
Fig. 2. Primary studies distribution by publication year.

The primary studies had their origin in 4 continents of the world, highlighting cities in Europe: Manchester, Cambridge, Lancaster, Hamburg, Oxford and Bristol; in North America: Toronto, San Francisco, Palo Alto, Seattle and Chicago; in Asia: Hong Kong, Beijing, Seoul, Bangalore and Manila; and Oceania: Sydney, Melbourne and Geelong.

The country where the subject has been studied the most is the United States, 50 primary studies were published in that country.

According to the inclusion and exclusion criteria, the articles that reported the results about any of the following processes were selected: 1) Design of a mental health application, 2) Development process of a mental health application, 3) Evaluation of an application or 4) Analysis of mental health applications. Due to the heterogeneity of the selected studies, most of them reported about more than one of the mentioned categories; 86 studies reported only about the evaluation of one or more applications, 22 reported about the analysis of mental health applications, 20 reported the design, development, and evaluation of an application, 15 the design and development processes, 5 only reported about the process of developing a mental health application, 2 reported about the development and evaluation of a mental health application and only 1 reported about the design process of a mental health application.

Regarding mental health conditions that are addressed in each of the primary studies, they were categorized based on the classification found in the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association [9]. From the total of primary studies, 72 were classified in the category of “mental disorders” because more than one mental disorder was addressed; within these studies, the most frequent conditions that were jointly addressed were depression, anxiety, and stress. 41 studies involved conditions belonging to depressive disorders classification; 19 studies involved conditions classified as trauma-related disorders and stress factors; 14 addressed conditions classified as anxiety disorders; 2 studies focused on conditions classified as spectrum of schizophrenia and other psychotic disorders; 2 addressed bipolar disorder; and the remaining 2 studies involved a condition classified in the category of conditions that need further study, which refers to suicidal behavior. The complete distribution of the primary studies by disorders is shown in Fig. 3.



**Fig. 3.** Primary studies distribution by disorder.

Depressive, anxiety, and stress disorders have been identified as the most studied conditions; this may be due to depression affecting millions of people in the world today.

In addition, depression is recognized to be the main cause of disability worldwide. After analyzing the presented results, it is possible to recognize the need for the detection of these conditions in the early stages.

### 3.3 Mental Health Applications

Within the primary studies that involve the design, development and/or evaluation process of one or more mobile applications, there were 130 in total, mentioning 121 applications. Of these 130 studies, 122 describe mobile applications, in 5 of the remaining primary studies the name of the mobile applications with which they worked were not reported, and the mobile applications described in the remaining 3 primary studies were not included in the list due to that they only got to the prototype phase. Detailed applications information is shown in Appendix B.

The features offered by each of the applications extracted from the studies are very diverse. However, some functionalities that they have in common stand out, such as: the registration of user activities; monitoring the symptoms of a particular condition; a diary, in which users can record how they felt during the day; information about the conditions being addressed; application of questionnaires to detect a specific mental health condition; even some more specialized applications record compliance with taking medications in patients who require it.

Regarding the operating system where the mobile applications run, 47 applications were developed for the dominant operating systems in the mobile phone market, Android and iOS; 39 were developed only for the Android operating system; 21 were implemented only for iOS; and of the remaining 14 applications the target operating system was not reported.

These results show the preference of application developers to implement their solutions in the two strongest operating systems on the market today. In some studies, it was mentioned that by developing applications compatible with these two operating systems, a greater number of users could be reached.

### 3.4 Strategies for the Development of Mobile Mental Health Applications

Within the set of primary studies, the process of design and/or development of 44 mental health applications were reported, in most of these studies the strategies used in the development of these applications were highlighted. The most mentioned strategy was the use of a user-centered design approach, developing techniques such as the creation of “Persona”, participatory design, empathy maps, focus groups, as well as interviews. Another of the mentioned strategies was the consultation with professionals in the mental health area to base the development of the mobile application in theory.

For studies reporting the evaluation of one or more mental health applications, a randomized controlled trial was developed with potential users of the applications. The objective of some of these tests was to evaluate the acceptance and usability of the applications. Within usability evaluations aspects such as ease of use, ease of learning, quality of information, satisfaction, among others, were studied. Of the most widely used scales to assess usability were the System Usability Scale (SUS) and the Mobile Application Rating Scale (MARS).

Studies that describe evaluating mental health applications used an app review approach, most of them in the top app stores, App Store for iOS apps and Play Store for Android apps. After obtaining the applications and filtering them, applications were evaluated quantitatively and qualitatively. Quantitative evaluations were performed based on the number of downloads and rating scores. In the case of qualitative evaluations, they were based on user reviews of the applications. In general, the problems that stood out the most were the usability of the applications.

## 4 Conclusions and Future Work

The main aim of the SLR was to identify mobile applications that address the most common mental health conditions. After the primary study selection process, out of a total of 450,815 studies, 152 met the inclusion and exclusion criteria.

Analysis of the results shows that a wide variety of mobile applications have been developed to improve the mental health of users. Most of these applications have been developed to mainly address conditions such as depression, anxiety, and stress.

However, a search in the iOS and Android application stores carried out in conjunction with this review showed that more than 50% of the applications were not found in the application stores, which would mean that the project was not continued.

Some of the primary studies that addressed the analysis of mental health applications mention the main problems that these types of tools have. The studies that were considered most relevant and the problems that were identified are discussed below.

Estrada, Wadley and Lederman in their article report the results of an analysis on the comments provided by users in the application stores; from the analysis, 4 main concerns were identified in the users: 1) Little emotional support from the application, 2) The application can become a distraction from real life, 3) The information provided to the application may differ from what that users talk to other people and 4) The use of applications can discourage face-to-face interactions. Taking these results as a reference, it is possible to identify which are some of the features that are most important for users of mental health applications and in this way, apply this knowledge to the tool to be developed, for example emotional support from the app, the relation between the real life and the application, the connection about the information that is provided to the app and the user actions and the usefulness of the app in encouraging the user to attend therapy.

Nicholas, Larsen, Proudfoot, and Christensen reported in their study that the mobile apps they analyzed had attachment-related problems in mental health theory. Most of the mobile applications did not refer to the guidelines used in clinical practice or to information related to psychoeducation. Even though all the applications specified the mental disorder for which they were developed, after evaluating their content, it was identified that few were developed according to the specific features to address each disorder. Another problem found is related to privacy and security, very few applications provided the user with a statement about the protection, storage and distribution of information. A very serious problem is the fact that the applications do not respond to situations in which users present extreme moods, including suicidal ideas. The results of this study highlight the deficiencies that exist in the mental health mobile applications



available in the market, such as bugs, issues related to information privacy, the lack of features to address each disorder, the response of the application to extreme situations, usability problems, etc.; as software developers, it is helpful to keep these shortcomings in mind when working on developments, in this case related to mental health. In this way, it is possible to develop quality interventions based on evidence on mental health that help to address the main mental disorders that affect a large part of the population.

In the Alqahtani and Orji study, a usability-focused analysis was conducted from user reviews. The study analyzed the comments of users of applications that were related to mental health, anxiety, depression or emotions. Issues identified in the comments were classified as bugs, UI design issues, lack of explanations, data loss, connectivity issues, and battery and memory usage issues.

Taking the results of these studies as a reference, it is possible to identify some recommendations to try to avoid the aforementioned problems. Since it has been identified that deficiencies related to usability have a very strong impact on the use and adoption of mobile health applications, one of the main recommendations is to use methods such as user-centered design, in this way it is possible to develop mobile applications taking into account the needs and preferences of end users. A suggestion that is constantly mentioned emphasizes developing applications based on mental health theory. It is also important that these applications adhere to the clinical practices used by health professionals; in this way, it will be possible to develop tools with specific features to address each disorder in a correct way. The privacy and security of users' information is a very important element in applications related to health, that is why it is important to implement mechanisms that protect users' information, as well as to inform them of the treatment that will be given to their personal information. A last but not least recommendation is to perform usability tests, in order to identify errors from the end user point of view and solve them before the application is available to the public.

These recommendations should not be taken lightly. According to the aforementioned, in recent years the development of applications focused on health has grown, however, most of these applications have problems that can result in low rates of adoption and/or use of the tool. Therefore, it is considered necessary to take into account each of the points mentioned above for the development of tools in the field of mental health.

The solution to be developed requires particular features previously detected. For example: the application of inventories for the detection of conditions such as anxiety, depression, and stress; daily record of students' mood; a web platform that shows the statistics of the inventory results and the students' state of mind, so that the authorities of the *Universidad Autónoma de Zacatecas* can make decisions proactively. As a consequence, it becomes unfeasible to use any of the applications found to provide solutions to the problems previously raised. However, strategies, successes and good practices used in the development of applications such as user-centered design, consultation with health professionals and usability tests, will be taken as the basis for the development of the raised application.

As future work, a mobile application will be developed to assist in the early detection of conditions such as depression, stress, anxiety, and anguish.

**Acknowledgement.** Thank you to Dr. Aldonso Becerra-Sánchez, for his advices in the definition of the background and planning the review used in the early stage of this work.

## Appendix A. Primary Studies

Id	Name	Year	Disorder
PS1	Mobile Mental Wellness Training for Stress Management: Feasibility and Design Implications Based on a One-Month Field Study	2013	Stress
PS2	A Comparison of Two Delivery Modalities of a Mobile Phone-Based Assessment for Serious Mental Illness: Native Smartphone Application vs Text-Messaging Only Implementations	2013	Mental disorders
PS3	The State of Mental Digi-Therapeutics: A Systematic Assessment of Depression and Anxiety Apps Available for Arabic Speakers	2020	Mental disorders
PS4	Usability Issues in Mental Health Applications	2019	Mental disorders
PS5	A mobile application to complement face-to-face interactions in psychological intervention for social anxiety management	2019	Social anxiety
PS6	The Use and Effectiveness of Mobile Apps for Depression: Results from a Fully Remote Clinical Trial	2016	Depression
PS7	Towards Early Detection of Depression through Smartphone Sensing	2019	Depression (MDD)
PS8	The Prevalence and Usage of Mobile Health Applications among Mental Health Patients in Saudi Arabia	2018	Mental disorders
PS9	Effects of a 12-min Smartphone-Based Mindful Breathing Task on Heart Rate Variability for Students with Clinically Relevant Chronic Pain, Depression, and Anxiety: Protocol for a Randomized Controlled Trial	2019	Mental disorders

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Id	Name	Year	Disorder
PS10	Engagement in mobile phone app for self-monitoring of emotional wellbeing predicts changes in mental health: MoodPrism	2018	Mental disorders
PS11	A randomized controlled trial of three smartphone apps for enhancing public mental health	2018	Mental disorders
PS12	Development and Pilot Evaluation of Smartphone-Delivered Cognitive Behavior Therapy Strategies for Mood and Anxiety-Related Problems: MoodMission	2018	Mental disorders
PS13	Applying the Principles for Digital Development: Case Study of a Smartphone App to Support Collaborative Care for Rural Patients with Posttraumatic Stress Disorder or Bipolar Disorder	2018	Bipolar disorder
PS14	Acceptability of mHealth augmentation of Collaborative Care: A mixed methods pilot study	2018	Mental disorders
PS15	There is a non-evidence-based app for that: A systematic review and mixed methods analysis of depression- and anxiety-related apps that incorporate unrecognized techniques	2020	Mental disorders
PS16	Transdiagnostic Mobile Health: Smartphone Intervention Reduces Depressive Symptoms in People with Mood and Psychotic Disorders	2019	Mental disorders
PS17	Self-Reflected Well-Being via a Smartphone App in Clinical Medical Students: Feasibility Study	2018	Mental disorders
PS18	Creating Live Interactions to Mitigate Barriers (CLIMB): A Mobile Intervention to Improve Social Functioning in People with Chronic Psychotic Disorders	2016	Psychosis
PS19	Does a Mobile Phone Depression-Screening App Motivate Mobile Phone Users with High Depressive Symptoms to Seek a Health Care Professional's Help?	2016	Depression

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Id	Name	Year	Disorder
PS20	MoodHacker Mobile Web App with Email for Adults to Self-Manage Mild-to-Moderate Depression: Randomized Controlled Trial	2016	Depression
PS21	Adding a smartphone app to Internet-based self-help for social anxiety: a randomized controlled trial	2018	Social anxiety
PS22	Behavior Analytics of Users Completing Ecological Momentary Assessments in the Form of Mental Health Scales and Mood Logs on a Smartphone App	2019	Mental disorders
PS23	A Mobile Application for Campus-based Psychosocial Wellness Program	2016	Mental disorders
PS24	Smartphone app to investigate the relationship between social connectivity and mental health	2017	Mental disorders
PS25	A Stress Management App Intervention for Cancer Survivors: Design, Development, and Usability Testing	2018	Stress
PS26	Addressing Depression Comorbid with Diabetes or Hypertension in Resource-Poor Settings: A Qualitative Study About User Perception of a Nurse-Supported Smartphone App in Peru	2019	Depression
PS27	Counseling with Guided Use of a Mobile Well-Being App for Students Experiencing Anxiety or Depression: Clinical Outcomes of a Feasibility Trial Embedded in a Student Counseling Service	2019	Mental disorders
PS28	Consumer smartphone apps marketed for child and adolescent anxiety: A systematic review and content analysis	2018	Anxiety
PS29	A Stress Relief App Intervention for Newly Employed Nursing Staff: Quasi-Experimental Design	2019	Stress

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Id	Name	Year	Disorder
PS30	A multi-faceted approach to characterizing user behavior and experience in a digital mental health intervention	2019	Mental disorders
PS31	Mood and Stress Evaluation of Adult Patients with Moyamoya Disease in Korea: Ecological Momentary Assessment Method Using a Mobile Phone App	2019	Stress
PS32	A Novel Mobile Phone App Intervention with Phone Coaching to Reduce Symptoms of Depression in Survivors of Women's Cancer: Pre-Post Pilot Study	2020	Depression
PS33	Developing Mental or Behavioral Health Mobile Apps for Pilot Studies by Leveraging Survey Platforms: A Do-it-Yourself Process	2020	Depression
PS34	Response Time as an Implicit Self-Schema Indicator for Depression Among Undergraduate Students: Preliminary Findings from a Mobile App-Based Depression Assessment	2019	Depression
PS35	Intermittent mindfulness practice can be beneficial, and daily practice can be harmful. An in depth, mixed methods study of the "Calm" app's (mostly positive) effects	2020	Mental disorders
PS36	A New Mental Health Mobile App for Well-Being and Stress Reduction in Working Women: Randomized Controlled Trial	2019	Stress
PS37	A Systematic, Multi-domain Review of Mobile Smartphone Apps for Evidence-Based Stress Management	2016	Stress
PS38	Development and Preliminary Feasibility Study of a Brief Behavioral Activation Mobile Application (Behavioral Appivation) to be used in Conjunction with Ongoing Therapy	2018	Depression

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Id	Name	Year	Disorder
PS39	Pilot randomized controlled trial of a Spanish-language Behavioral Activation mobile app (¡Aptívate!) for the treatment of depressive symptoms among united states Latinx adults with limited English proficiency	2019	Depression
PS40	Pilot Randomized Trial of a Self-Help Behavioral Activation Mobile App for Utilization in Primary Care	2019	Depression
PS41	A Mobile Phone App to Improve the Mental Health of Taxi Drivers: Single-Arm Feasibility Trial	2020	Mental disorders
PS42	Mobile Apps for Suicide Prevention: Review of Virtual Stores and Literature	2017	Suicide risk
PS43	A Mental Health Chatbot for Regulating Emotions (SERMO) - Concept and Usability Test	2020	Mental disorders
PS44	Salutary effects of an attention bias modification mobile application on biobehavioral measures of stress and anxiety during pregnancy	2017	Mental disorders
PS45	Development of an Ambulatory Biofeedback App to Enhance Emotional Awareness in Patients with Borderline Personality Disorder: Multicycle Usability Testing Study	2019	Mental disorders
PS46	Integration of a Technology-Based Mental Health Screening Program into Routine Practices of Primary Health Care Services in Peru (The Allillanchu Project): Development and Implementation	2018	Mental disorders
PS47	Brief report: Feasibility of a mindfulness and self-compassion based mobile intervention for adolescents	2016	Mental disorders
PS48	A mobile application for panic disorder and agoraphobia: Insights from a multi-methods feasibility study	2020	Panic disorder

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Id	Name	Year	Disorder
PS49	Long-Term Outcomes of a Therapist-Supported, Smartphone-Based Intervention for Elevated Symptoms of Depression and Anxiety: Quasi experimental, Pre-Postintervention Study	2019	Mental disorders
PS50	A Feasibility Trial of Power Up: Smartphone App to Support Patient Activation and Shared Decision Making for Mental Health in Young People	2019	Mental disorders
PS51	Development and Long-Term Acceptability of ExPRESS, a Mobile Phone App to Monitor Basic Symptoms and Early Signs of Psychosis Relapse	2019	Psychosis
PS52	'It feels different from real life': Users' Opinions of Mobile Applications for Mental Health	2015	Mental disorders
PS53	A Mobile App-Based Intervention for Depression: End-User and Expert Usability Testing Study	2018	Depression
PS54	Cognitive and Behavioral Skills Exercises Completed by Patients with Major Depression During Smartphone Cognitive Behavioral Therapy: Secondary Analysis of a Randomized Controlled Trial	2018	Depression
PS55	Young People's Response to Six Smartphone Apps for Anxiety and Depression: Focus Group Study	2019	Mental disorders
PS56	Automated Mobile Phone-Based Mental Health Resource for Homeless Youth: Pilot Study Assessing Feasibility and Acceptability	2019	Mental disorders
PS57	Feasibility of a Therapist-Supported, Mobile Phone-Delivered Online Intervention for Depression: Longitudinal Observational Study	2019	Depression
PS58	A Peer-Led Electronic Mental Health Recovery App in a Community-Based Public Mental Health Service: Pilot Trial	2019	Mental disorders

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Id	Name	Year	Disorder
PS59	Early Signs Monitoring to Prevent Relapse in Psychosis and Promote Well-Being, Engagement, and Recovery: Protocol for a Feasibility Cluster Randomized Controlled Trial Harnessing Mobile Phone Technology Blended with Peer Support	2020	Mental disorders
PS60	Validity of Mind Monitoring System as a Mental Health Indicator using Voice	2016	Mental disorders
PS61	Efficacy of an internet and app-based gratitude intervention in reducing repetitive negative thinking and mechanisms of change in the intervention's effect on anxiety and depression: Results from a randomized controlled trial	2019	Mental disorders
PS62	A Behavioral Activation Mobile Health App for Smokers with Depression: Development and Pilot Evaluation in a Single-Arm Trial	2019	Depression
PS63	Youth Codesign of a Mobile Phone App to Facilitate Self-Monitoring and Management of Mood Symptoms in Young People with Major Depression, Suicidal Ideation, and Self-Harm	2018	Mental disorders
PS64	Gamification in Stress Management Apps: A Critical App Review	2017	Stress
PS65	Efficacy of the Mindfulness Meditation Mobile App "Calm" to Reduce Stress Among College Students: Randomized Controlled Trial	2019	Stress
PS66	Smartphone-based ecological momentary assessment for Chinese patients with depression: An exploratory study in Taiwan	2016	Depression
PS67	Effect of Brief Biofeedback via a Smartphone App on Stress Recovery: Randomized Experimental Study	2019	Stress

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Id	Name	Year	Disorder
PS68	An Empathy-Driven, Conversational Artificial Intelligence Agent (Wysa) for Digital Mental Well-Being: Real-World Data Evaluation Mixed-Methods Study	2018	Depression (MDD)
PS69	Use of a smartphone application to screen for depression and suicide in South Korea	2017	Mental disorders
PS70	Accuracy of a Chatbot (Ada) in the Diagnosis of Mental Disorders: Comparative Case Study with Lay and Expert Users	2019	Mental disorders
PS71	Depression Screening Using Daily Mental-Health Ratings from a Smartphone Application for Breast Cancer Patients	2016	Depression
PS72	Associations Among Emotional State, Sleep Quality, and Resting-State EEG Spectra: A Longitudinal Study in Graduate Students	2020	Mental disorders
PS73	Free mobile apps on depression for Indian users: A brief overview and critique	2017	Depression
PS74	Quantifying App Store Dynamics: Longitudinal Tracking of Mental Health Apps	2016	Depression
PS75	Uptake and usage of IntelliCare: A publicly available suite of mental health and well-being apps	2016	Mental disorders
PS76	Android and iPhone Mobile Apps for Psychosocial Wellness and Stress Management: Systematic Search in App Stores and Literature Review	2020	Stress
PS77	Evaluation of an mHealth App (DeStressify) on University Students' Mental Health: Pilot Trial	2018	Mental disorders
PS78	Designing Daybuilder: An Experimental App to Support People with Depression	2012	Depression

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Id	Name	Year	Disorder
PS79	A randomized controlled trial on a smartphone self-help application (Be Good to Yourself) to reduce depressive symptoms	2018	Depression
PS80	Stress management for middle managers via an acceptance and commitment-based smartphone application: A randomized controlled trial	2014	Stress
PS81	A fully automated conversational agent for promoting mental well-being: A pilot RCT using mixed methods	2017	Mental disorders
PS82	Efficacy and Moderation of Mobile App-Based Programs for Mindfulness-Based Training, Self-Compassion Training, and Cognitive Behavioral Psychoeducation on Mental Health: Randomized Controlled Noninferiority Trial	2018	Mental disorders
PS83	Smartphone Cognitive Behavioral Therapy as an Adjunct to Pharmacotherapy for Refractory Depression: Randomized Controlled Trial	2017	Depression
PS84	Interaction and Engagement with an Anxiety Management App: Analysis Using Large-Scale Behavioral Data	2018	Anxiety
PS85	Use of a Mobile Phone App to Treat Depression Comorbid with Hypertension or Diabetes: A Pilot Study in Brazil and Peru	2019	Depression
PS86	The challenger app for social anxiety disorder: New advances in mobile psychological treatment	2015	Social anxiety
PS87	iCare-Stress: An Integrated Mental Health Software	2017	Mental disorders

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*(continued)*

Id	Name	Year	Disorder
PS88	Guided Self-Help Works: Randomized Waitlist Controlled Trial of Pacifica, a Mobile App Integrating Cognitive Behavioral Therapy and Mindfulness for Stress, Anxiety, and Depression	2019	Mental disorders
PS89	MedLink: A mobile intervention to address failure points in the treatment of depression in general medicine	2015	Depression
PS90	IntelliCare: An Eclectic, Skills-Based App Suite for the Treatment of Depression and Anxiety	2017	Mental disorders
PS91	Comparing usage of a web and app stress management intervention: An observational study	2018	Stress
PS92	Incorporation of a Stress Reducing Mobile App in the Care of Patients with Type 2 Diabetes: A Prospective Study	2017	Stress
PS93	Anti-depression and anti-suicidal application	2020	Depression
PS94	Immediate Mood Scaler: Tracking Symptoms of Depression and Anxiety Using a Novel Mobile Mood Scale	2017	Mental disorders
PS95	Assessing Real-Time Moderation for Developing Adaptive Mobile Health Interventions for Medical Interns: Micro-Randomized Trial	2020	Mental disorders
PS96	Capturing and Analyzing Pervasive Data for SmartHealth	2014	Mental disorders
PS97	Mobile Apps for Bipolar Disorder: A Systematic Review of Features and Content Quality	2015	Trastorno bipolar
PS98	The WorkingWell Mobile Phone App for Individuals with Serious Mental Illnesses: Proof-of-Concept, Mixed-Methods Feasibility Study	2018	Mental disorders

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Id	Name	Year	Disorder
PS99	Smartphone-based safety planning and self-monitoring for suicidal patients: Rationale and study protocol of the CASPAR (Continuous Assessment for Suicide Prevention and Research) study	2018	Suicide risk
PS100	Reviewing the data security and privacy policies of mobile apps for depression	2019	Depression
PS101	Testing an app-assisted treatment for suicide prevention in a randomized controlled trial: Effects on suicide risk and depression	2019	Mental disorders
PS102	Evaluation of a Mobile Device Survey System for Behavioral Risk Factors (SHAPE): App Development and Usability Study	2019	Mental disorders
PS103	Developing an Application for Dealing with Depression through the Analysis of Information and Requirements found in Groups from a Social Network	2018	Depression
PS104	Psychologist in a Pocket: Lexicon Development and Content Validation of a Mobile-Based App for Depression Screening	2016	Depression
PS105	A Randomized Controlled Trial of the PTSD Coach Mobile Health App at Reducing Pain and Psychological Symptoms among Injured Emergency Department Patients: Preliminary Results	2019	Posttraumatic stress disorder (PTSD)
PS106	How private is your mental health app data? An empirical study of mental health app privacy policies and practices	2019	Mental disorders
PS107	Designing a Mobile Application to Support the Indicated Prevention and Early Intervention of Childhood Anxiety	2015	Anxiety
PS108	eMindLog: Self-Measurement of Anxiety and Depression Using Mobile Technology	2017	Mental disorders

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Id	Name	Year	Disorder
PS109	Worker Preferences for a Mental Health App Within Male-Dominated Industries: Participatory Study	2018	Mental disorders
PS110	Development and initial evaluation of a mobile application to help with mindfulness training and practice	2017	Mental disorders
PS111	Efficacy of the Digital Therapeutic Mobile App BioBase to Reduce Stress and Improve Mental Well-Being Among University Students: Randomized Controlled Trial	2020	Stress
PS112	Co-designing the Aboriginal and Islander Mental Health Initiative for Youth (AIMhi-Y) App: Results of a formative mixed methods study	2020	Mental disorders
PS113	Using Mobile Health Gamification to Facilitate Cognitive Behavioral Therapy Skills Practice in Child Anxiety Treatment: Open Clinical Trial	2018	Anxiety
PS114	Using Mobile Apps to Assess and Treat Depression in Hispanic and Latino Populations: Fully Remote Randomized Clinical Trial	2018	Depression
PS115	Exploring the Time Trend of Stress Levels While Using the Crowdsensing Mobile Health Platform, TrackYourStress, and the Influence of Perceived Stress Reactivity: Ecological Momentary Assessment Pilot Study	2019	Stress
PS116	Functionality of Top-Rated Mobile Apps for Depression: Systematic Search and Evaluation	2020	Depression
PS117	Validation of an mHealth App for Depression Screening and Monitoring (Psychologist in a Pocket): Correlational Study and Concurrence Analysis	2019	Depression
PS118	Testing the acceptability and initial efficacy of a smartphone-app mindfulness intervention for college student veterans with PTSD	2020	Posttraumatic stress disorder (PTSD)

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Id	Name	Year	Disorder
PS119	Development of a Mobile Phone App to Support Self-Monitoring of Emotional Well-Being: A Mental Health Digital Innovation	2016	Mental disorders
PS120	Availability, readability, and content of privacy policies and terms of agreements of mental health apps	2019	Mental disorders
PS121	Posttraumatic Stress Disorder and Mobile Health: App Investigation and Scoping Literature Review	2017	Posttraumatic stress disorder (PTSD)
PS122	SmileTeq: An Assistive and Recommendation Mobile Application for People with Anxiety, Depression or Stress	2019	Mental disorders
PS123	Physician Anxiety and Burnout: Symptom Correlates and a Prospective Pilot Study of App-Delivered Mindfulness Training	2020	Anxiety
PS124	Beam: a mobile application to improve happiness and mental health	2014	Mental disorders
PS125	Mobile app for stress monitoring using voice features	2015	Stress
PS126	A Mobile Phone–Based Intervention to Improve Mental Health Among Homeless Young Adults: Pilot Feasibility Trial	2019	Mental disorders
PS127	Mental Health Apps in China: Analysis and Quality Assessment	2019	Mental disorders
PS128	Speech Analysis and Depression	2016	Depression
PS129	Finding a Depression App: A Review and Content Analysis of the Depression App Marketplace	2015	Depression
PS130	Using a Smartphone App and Clinician Portal to Enhance Brief Cognitive Behavioral Therapy for Childhood Anxiety Disorders	2020	Anxiety
PS131	Self-Directed Engagement with a Mobile App (Sinaspri) and Its Effects on Confidence in Coping Skills, Depression, and Anxiety: Retrospective Longitudinal Study	2018	Mental disorders

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Id	Name	Year	Disorder
PS132	Feasibility of mobile mental wellness training for older adults	2018	Depression
PS133	Imagine your mood: Study design and protocol of a randomized controlled micro-trial using app-based experience sampling methodology to explore processes of change during relapse prevention interventions for recurrent depression	2017	Depression (MDD)
PS134	User Experience of Cognitive Behavioral Therapy Apps for Depression: An Analysis of App Functionality and User Reviews	2018	Depression
PS135	Development of a Mobile Application for People with Panic Disorder as augmentation for an Internet-based Intervention	2013	Panic disorder
PS136	Exploring User Learnability and Learning Performance in an App for Depression: Usability Study	2017	Depression
PS137	Usability of a Smartphone Application to Support the Prevention and Early Intervention of Anxiety in Youth	2017	Anxiety
PS138	Towards Situation-aware Mobile Applications in Mental Health	2016	Mental disorders
PS139	Development of a Digital Content-Free Speech Analysis Tool for the Measurement of Mental Health and Follow-Up for Mental Disorders: Protocol for a Case-Control Study	2020	Mental disorders
PS140	Mental Health App Design – A Journey from Concept to Completion	2015	Anxiety
PS141	Utilizing a Personal Smartphone Custom App to Assess the Patient Health Questionnaire-9 (PHQ-9) Depressive Symptoms in Patients with Major Depressive Disorder	2015	Depression (MDD)
PS142	Daily longitudinal self-monitoring of mood variability in bipolar disorder and borderline personality disorder	2016	Mental disorders

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Id	Name	Year	Disorder
PS143	An App That Incorporates Gamification, Mini-Games, and Social Connection to Improve Men's Mental Health and Well-Being (MindMax): Participatory Design Process	2018	Mental disorders
PS144	Naturalistic evaluation of a sport-themed mental health and wellbeing app aimed at men (MindMax), that incorporates applied video games and gamification	2020	Mental disorders
PS145	Development of a Mobile Clinical Prediction Tool to Estimate Future Depression Severity and Guide Treatment in Primary Care: User-Centered Design	2018	Depression
PS146	Effects of a Mindfulness Meditation App on Subjective Well-Being: Active Randomized Controlled Trial and Experience Sampling Study	2019	Mental disorders
PS147	A review of popular smartphone apps for depression and anxiety: Assessing the inclusion of evidence-based content	2019	Mental disorders
PS148	Experiences of General Practitioners and Practice Support Staff Using a Health and Lifestyle Screening App in Primary Health Care: Implementation Case Study	2018	Mental disorders
PS149	Human-Centered Development of an Activity Diary App for People with Depression	2019	Depression
PS150	Adapting a Psychosocial Intervention for Smartphone Delivery to Middle-Aged and Older Adults with Serious Mental Illness	2017	Mental disorders
PS151	An Online- and Mobile-Based Application to Facilitate Exposure for Childhood Anxiety Disorders	2019	Anxiety
PS152	Emotion-Polarity Visualizer on Smartphone	2019	Mental disorders

## Appendix B. Mobile Applications



Application name	Platform	Meru Health	Not reported	BackUP	Android & iOS
ClintTouch	Android & iOS	Stay Strong App	iOS	mEMA	Android & iOS
Appxiety	Android	EMPOWER	Not reported	LifeApp'tite	Not reported
Ipst	Android & iOS	MIMOSYS	Android	SHAPE	Android & iOS
Health Tips	Android & iOS	GET ON Gratitude	Android & iOS	Yuu	Android
EVO	Android & iOS	Actify	iOS	PSTD Coach	Android & iOS
Me	Android	iHOPE	Android & iOS	REACH	Android & iOS
Mindfulness Meditation app	Not reported	Happify	Android & iOS	eMindLog	Android & iOS
MoodMission	Android	Wysa	Android & iOS	HeadGear	Android & iOS
MoodPrism	Android & iOS	Ada	Android & iOS	Mindfulness	Android
MoodKit	Android & iOS	Pit-a-Pat	Android & iOS	BioBase	Android & iOS
SPRIT	Android	Daily Sampling System	Android	ALMhi-Y	Not reported
Ginger Emotional Support	Android & iOS	Aspire	Android & iOS	TrackYourStress	Android & iOS
FOCUS	Not reported	Day to Day	Android	Psychologist in a Pocket	Android
Particip8	Android & iOS	Daily Feats	Android	SmileTeq	Not reported
CLIMB	iOS	Worry Knot	Android	Unwinding Anxiety	Android & iOS
Depression Monitor	iOS	ME Locate	Android	Beam	Android
MoodHacker	Android & iOS	Social Force	Android	StressID	Android
Challenger	iOS	My Mantra	Android	Pocket Helper	Not reported
Moment Health	Android	Thought Challenger	Android	HearMeOut	Android
PsychUP	Android	iCope	Android	SmartCat	Android
StressPuffen	Android & iOS	MoveMe	Android	Sinaspriete	Android & iOS
SR_APP	Not reported	Slumber Time	Android	Oiva	Android & iOS
PsyMate	Android & iOS	DeStressify	Android & iOS	Imagine your modo	Not reported
iCan Thrive	Android	DayBuilder	iOS	GET ON PAPP	Android & iOS
K-CESD-R	Android & iOS	Be Good to Yourself	iOS	Thought Challenger	Android
Calm	Android & iOS	Viary	iOS	StiumMan	Android & iOS
Florescer	Android & iOS	Shim	Not reported	MoodBuster	Android
Behavioral Appivation	iOS	Living with heart	Android & iOS	VoiceSense	Android & iOS
Appriate	Android & iOS	Kokoro-app	iOS	Self-help for Anxiety Management	Android & iOS
Moodivate	iOS	CONEMO	Not reported	Mindful Moods	Android & iOS
Driving to Health	Android & iOS	iCare-Stress	Android	MoodZoom	Android
SERMO	Android & iOS	Pacificia, now Sanvello	Android & iOS	MindMax	Android & iOS
PersonalZen	iOS	MedLink	Android	Wildflowers	iOS
SenseIT	Android	Healthy Mind	Android	Check Up GP	Not reported
BodiMojo	iOS	Serenita	Android & iOS	Dacemo	iOS
PowerUp	Android & iOS	Anti depression and anti suicidal	Android	AnxietyCoach	iOS
BlueWatch	iOS	Immediate Mood Scaler	iOS	PNViz	Android
Music eSpace	iOS	INTERN HEALTH	Android & iOS		
Headspace	iOS	SmartMood	Not reported		
What's Up	iOS	WorkingWell	Android		
Mindshift	iOS				

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