

A Systematic Literature Review of the use of Artificial Intelligence (AI) or Mobile Applications for Depression Therapy

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Abstract: *Depression is a disease that affects one in five people across the globe, including approximately 16 million people in the United States alone. Technology advances have in the last decade, have created significant opportunities for artificial intelligence (AI) and mobile applications to improve the delivery of mental health care. This systematic literature review aimed to determine if the use of artificial intelligence (AI) or mobile applications for depression therapy will improve patient outcomes and prove to be effective. A search was conducted using the PubMed/Medline and CINAHL academic databases following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Data from 20 relevant articles were meticulously analyzed using screening criteria that revolved around our research question. The authors identified five themes during this process. The themes included the acceptability or feasibility of using AI or apps, the effectiveness or efficacy of self-guided therapy apps or AI, engagement or adherence to using the AI or apps results in better outcomes, positive impacts on depression symptoms and the use of AI or apps as a therapy aide. The findings and results indicate that the use of mobile apps or other advanced technology (AI) is poised to change the face of psychological assessment and intervention. The findings of this study imply that AI technologies for mental health are effective and innovative and will continue to improve quality and access to health care.*

Keywords—depression; self-guide therapy apps; mobile apps; apps; mobile applications; AI; artificial intelligence

1. INTRODUCTION

Mental health is a growing and challenging health care problem in the United States. Of particular concern is depression. Depression is a serious mental health condition that requires understanding and treatment [18]. According to the National Institute of Mental Health, the prevalence of depression is alarming. 6.9% of adults in America or roughly 16 million people will experience at least one major depressive episode in a given year.²⁰ Furthermore, mood disorders, such as major depression, are the third most common cause of hospitalization in the United States for adults between the ages of 18–44 [27].

Patients with depression are typically diagnosed and treated in a primary-care setting. However, many of these primary-care diagnosed patients who are referred for therapy with mental health professionals, fail to follow through and initiate treatment [25]. There are numerous barriers to face-to-face depression interventions that prevent many from seeking care [25]. As such, alternative treatment techniques such as mobile apps are being explored to treat patients with depression [25]. Left untreated depression can be devastating; however, most patients respond well to treatment. Treatments typically include psychotherapy, pharmaceutical therapy, and various other interventions [18].

In recent years significant advances in artificial intelligence technology (AI) have created significant opportunities for improving the delivery of healthcare and mental health services are ripe for adoption of these delivery

models [3] There are a wealth of available mental health applications available to clinicians and patients today.

However, it is unknown if the use of artificial intelligence (AI) applications for treating individuals with depressive will improve treatment outcomes. Recent research on the topic suggests positive outcomes of using AI with significantly reduced symptomology; however, proof of effectiveness and efficacy is more elusive [14].

The purpose of this study is to conduct a systematic literature review to determine whether or not the use of artificial intelligence (AI) or mobile applications for depression therapy will improve patient outcomes and prove to be effective.

2. METHODS

The literature search process used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. PRISMA guidelines include searching for pertinent studies, screening for inclusion and exclusion criteria, data extraction based on the screening for criteria, synthesis of the data to identify key themes, and finally reporting the findings [16, 24]. The process used for selecting the articles in this review is illustrated in Fig. 1. After utilizing Google Scholar to narrow our topic choice, the authors then conducted a systematic search using the PubMed and CINAHL research databases. Google Scholar was purposefully excluded due to an excessive amount of unrelated results with the broad search terms. Studies and reviews published between 2015 and 2019 were included to capture the most current material on the topic. A Boolean search was conducted using broad search terms with Boolean search operators included. The key terms used in the search included depression, outcomes or benefits or effects, and mobile apps or mobile applications or apps. Because PubMed queries MEDLINE, it was omitted from the CINAHL search. The initial search returned 479 results combined.

2.1 EXCLUSION CRITERIA

Filters were applied to both PubMed (MEDLINE) and CINAHL to exclude articles outside of the selected study time frame of 2015-2019, and those not included in academic peer-reviewed journals. Additional filters were applied to include full text only and to return results only in the English language. Because PubMed queries MEDLINE, a filter was used in CINAHL to exclude MEDLINE results. These filters excluded 293 articles.

The remaining 186 articles were screened by one reviewer and a determination made as to whether the article was germane to the study. This exclusion process was completely manual and removed an additional 166 articles. Of the articles excluded, most were related to mobile apps used in the treatment of health conditions other than depression. Also, articles were omitted that pertained to protocols for planned or future trials. The screening criteria were structured around our research question; does the use of artificial intelligence (AI) or mobile applications for depression therapy improve patient outcomes and prove to be effective? Articles not relevant to this objective were excluded. The final sample was 20 articles.

concentrated on the consumer while only a few studies are focused on therapists.

An affinity matrix was used to illustrate the frequency of mention or the discussion of a particular topic. For this review, an affinity matrix was constructed to identify the occurrences of common themes in the literature relative to patient outcomes and effectiveness or efficacy of AI apps. This matrix can be located in *Table 2*. Overall there were five recurrent themes throughout the literature. The five themes included (a) the acceptability or feasibility of using AI or apps, (b) the effectiveness or efficacy of self-guided therapy apps or AI, (c) the greater the engagement or adherence to using the AI or apps results in better outcomes, (d) positive impact on depression symptoms and disability via PHQ-9 and (e) the best results are achieved when the AI or app is used as a therapy aid instead of a stand-alone treatment. In total, there were 55 mentions of pertinent information in the articles about improved patient outcomes and the effectiveness of mobile apps or AI interventions in treating patients with depressive symptoms.

From the research findings, a total of 12 out of 20 (60%) articles reported positive acceptance or feasibility of treating depressive symptomology with AI or mobile apps [2, 4, 6, 7-9, 13, 15, 19, 21, 23, 25]. 12 out of 20 (60%) articles reported positive results on the effectiveness or efficacy of AI or mobile apps [1, 2, 5, 8, 10-13, 17, 22, 23, 25]. 13 out of 20 (65%) articles inferred that better outcomes are the result of higher adherence to or patient engagement with the technology [1, 2, 4, 8-11, 15, 17, 21, 23, 25, 26]. Ten out of 20 (50%) articles report a definite improvement over time of depressive symptomology in users of AI or mobile apps [1, 2, 8, 9, 11, 14, 16, 20, 22, 24, 25]. Eight out of 20 (40%) articles suggested that AI or mobile apps worked best as therapeutic aids instead of stand-alone treatments [5, 6, 9, 10, 12, 15, 17, 25].

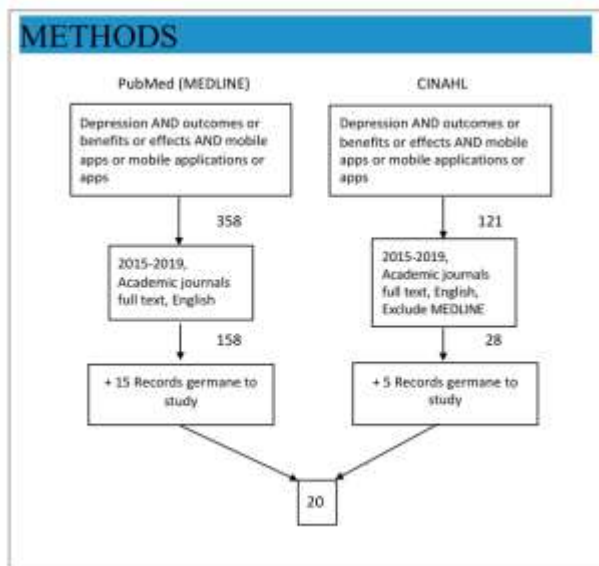


Fig. 1. Literature Review Process

3. RESULTS

The broad term search criteria produced a well-rounded sampling of the literature, the author carefully reviewed a total of 20 articles for common themes. Table 1 provides a detailed summary of the articles. The majority of the studies

Table 1: Summarized findings of the literature

Title	Findings
The Use and Effectiveness of Mobile Apps for Depression: Results from a Fully Remote Clinical Trial [1]	Mobile apps have the potential to overcome access to care barriers. The study tested three apps: EVO iPST and Health Tips. The results revealed that apps have the most impact on those with mild depression and that engagement/adherence is an issue that needs to be further explored.
Depression screening via a smartphone app: cross-country user characteristics and feasibility [2]	The findings imply that smartphone apps are useful and feasible for screening for depression and exhibit high potential for this purpose. Besides, apps have promise for use in self-monitoring and health education, in younger adults.
A feasibility study of a mental health mobile app in the Dominican Republic: The untold story [4]	The app studied - the El Buen Consejo Movil (EBCM), which was designed to be a stand-alone psychoeducation tool for depression was deemed unfeasible in the Dominican Republic. The app's failure was mostly due to many barriers like access to phones and tech literacy. These barriers also translate to high-income countries as well.
Internet and mobile interventions for depression: Opportunities and challenges [5]	Innovative internet and mobile interventions have the potential to increase access to evidence-based depression treatments as well as enhance their effects. The findings suggest that there are minimal differences in the effectiveness of all psychotherapy interventions, whether they are face-to-face or self-guided using technology.
Psychotherapy and Artificial Intelligence: A Proposal for Alignment [6]	In brief psychotherapy, AI has a role as an additional resource. Combining AI with psychotherapy is recommended.
Mental Health Mobile Apps' Instruction: Technology Adoption Theories Applied in a Mixed Methods Study of Counseling Faculty [7]	The Department of Health and Human Services is driving a paradigm shift towards patient-centered care using eHealth. Furthermore, Mental Health Mobile Applications (MHMA) represent billions of downloads by health consumers. The acceptance of MHMAs as therapeutic tools by counselors faces some challenges such as technical literacy and evidence of efficacy and effectiveness, and thus, more training is required. The findings of the study are that education of counselors about using MHMAs lacks possibly due to the nature of mental health therapy being mainly a social vice a technological interaction
Using Psychological Artificial Intelligence (Tess) to Relieve Symptoms of Depression and Anxiety: Randomized Controlled Trial [8]	A randomized controlled trial to test the efficacy and feasibility of using psychological AI (Tess) to reduce depression symptoms; the results of which show a statistically significant reduction in depressive symptoms which implies that AI can serve as a cost-effective and accessible, and feasible option for delivering therapeutic support for depression and anxiety.
A Mobile Application for Monitoring and Management of Depressed Mood in a Vulnerable Pregnant Population [9]	The study of a Mood Tracking mobile app; the results of which showed improved delivery of mental healthcare and increased patient engagement in obstetric care of pregnant patients with depressive symptoms.
Technology-enhanced human interaction in psychotherapy [10]	The application of technology to psychotherapy must capitalize on and enhance human capacities to improve the quality of psychotherapy successfully; how this shift will affect models of care remains to be seen.
An Empathy-Driven, Conversational Artificial Intelligence Agent (Wysa) for Digital Mental Well-Being: Real-World Data Evaluation Mixed-Methods Study [11]	A study of the AI chatbot Wysa app, the results of which reveal the improvement of depression symptoms among users. Participants reported that the app was both helpful and encouraging. The effectiveness and engagement levels of Wysa app for symptoms of depression is promising but needs a more extensive and more extended study.
The dawn of eMental health professional [12]	This article concludes that there is a need for more research and randomized controlled trials before mental health professionals can safely and effectively use technology to aid in treating patients.

Table continues

Title	Findings
Adoption of Mobile Apps for Depression and Anxiety: Cross-Sectional Survey Study on Patient Interest and Barriers to Engagement [13]	The adoption of mHealth interventions for the treatment of mental illness such as depression remains low. This study examines the use and factors that impact the use of mHealth apps for mental illness from the patient's perspective.
Smartphone-Supported versus Full Behavioural Activation for Depression: A Randomised Controlled Trial [15]	The results of this study could not determine the efficacy of a blended treatment program consisting of a smartphone application when used as an addition to face-to-face therapy for depression. The results revealed no real differences in the outcomes variable between the blended treatment and the face-to-face sessions.
IntelliCare: An Eclectic, Skills-Based App Suite for the Treatment of Depression and Anxiety [17]	The findings of this feasibility study for the IntelliCare suite of 13 apps with coaching show reductions in symptoms of depression consistently across many demographic variables. Additionally, the research shows that IntelliCare has the potential to be very cost-effective.
How people with serious mental illness use smartphones, mobile apps, and social media [19]	This article is a survey of how people with a serious mental illness (SMI) use mobile devices to highlight the potential of the use of mobile technology in support of illness self-management and symptom monitoring among people living with SMI.
Using Mobile Apps to Assess and Treat Depression in Hispanic and Latino Populations: Fully Remote Randomized Clinical Trial [21]	This article is a dual aim study, the second of which investigated three self-guided mobile apps for treatment outcomes. This study confirms that mHealth platforms have the potential to deliver on-demand and mental health intervention alternatives for closing the treatment gaps. Treatment outcomes did not vary by app, and depressive symptoms improved as based on PHQ-9 scores in about half of participants.
Smartphone Applications for Mental Health [22]	The findings of this study are that smartphone apps for symptom relief are readily available; however, their usefulness is uncertain; therefore, mental health patients should seek and use apps which are patient-centered and evidence-based.
Behavioral and cognitive intervention strategies delivered via coached apps for depression: Pilot trial [25]	This article is a study of smartphone apps to evaluate their usage and efficacy. PHQ-9 scores are used to assess depressive symptoms. The findings of this study indicate that apps for depression intervention have a positive impact on symptomology and have the potential to overcome barriers to care in the primary care setting.
Mobile Sensing and Support for People with Depression: A Pilot Trial in the Wild [26]	This article is a study of 126 adults using the smartphone app Mobile Sensing and Support (MOSS). Adherence to the use of the app over a significant period resulted in improved depression symptoms as measured by PHQ-9 scores which implies that the MOSS app can provide meaningful intervention in support of people with depression in their everyday lives.

Table 2: Frequency of occurrence in the literature

Benefits	Occurrences	Instances of Attributes (n)	Percentage (%)
Acceptability or feasibility	2, 4, 6, 7, 8, 9, 13, 15, 19, 21, 23, 25	12	60%
Effectiveness or efficacy of self-guided therapy apps or AI	1, 2, 5, 8, 10, 11, 12, 13, 17, 22, 23, 25	12	60%
Greater engagement or adherence with AI or apps lead to better outcomes	1, 2, 4, 8, 9, 10, 11, 15, 17, 21, 23, 25, 26	13	65%
Positive impact on depression symptoms and disability via PHQ-9	1, 2, 8, 9, 11, 15, 17, 21, 23, 25, 26	10	50%
Best results when used as a therapy aid instead of a stand-alone treatment	5, 6, 9, 10, 12, 15, 17, 25	8	40%

4. DISCUSSION

Depression affects approximately one in five people annually worldwide [5]. The treatment of depression has evolved over the last decade resulting in new technological and innovative technologies that can improve the effects of treatment [5]. Smartphones for one have advanced software capabilities which allow them to function much like a computer. Also, they account for about 65% of all mobile phone users in the United States [2]. As such the use of mobile apps or other advanced technology (AI) is poised to change the face of psychological assessment and intervention [7]. In this systematic review, the author aimed to determine if the use of artificial intelligence (AI) or mobile applications for depression therapy would improve patient outcomes and prove to be effective. The research revealed as Table 2 delineates, five common attributes throughout the literature. These attributes support the assertion that AI and mobile apps have the potential to improve patient outcomes and be an effective treatment option for depression therapy.

The feasibility and acceptability of using mobile apps or AI in the treatment of depression were substantiated by a significant percentage (60%) of the articles in this review [2, 4, 6, 7-9, 13, 15, 19, 21, 23, 25]. BinDhim et al. concludes that apps have a significant role in the treatment of depression to include screening, self-monitoring, and patient education.⁷ The effectiveness or efficacy of mobile apps or AI for treating depression was corroborated in 60% of the articles reviewed as measured by the PHQ-9 [1, 2, 5, 8, 10-13, 17, 22, 23, 25]. Several authors report a significant reduction in depression

symptoms self-reported on the PHQ-9 [8, 9, 11]. Many of the studies indicate that more significant successes were possible when there was a higher engagement with the technology. Higher engagement is shown to yield better outcomes and a more substantial improvement in depression symptomologies [2, 4, 8-11, 15, 17, 21, 23, 25, 26]. Inkster et al. reports that high users of the application in the study had a significantly greater improvement as compared to the lower user's group.¹¹ In contrast, several authors proposed that mobile apps and AI were best used as a therapy aid vice a stand-alone treatment option [5, 6, 9, 10, 12, 15, 17, 25]. Regardless, the results of this review substantiate that the use of AI and mobile apps can be useful and improve outcomes when used for treating depression.

Notwithstanding the findings above, this review had some limitations that included practical time constraints, the exclusion of non-English language articles, the search strategies used, and the subjective nature of the reviewers. This review was conducted over eight weeks. The review excluded non-English language articles which eliminated certain publications from the review. The literature review was performed using a preliminary search strategy using Google Scholar first. An additional search strategy was then conducted using PubMed (MEDLINE) and CINAHL academic databases for reviewing peer-reviewed journal articles. The search was keyword guided. As such, it is possible that some articles were missed that could have been captured if different terminology was used for searching the academic databases. The last limitation is the subjective

nature of the reviewer of the articles. There is the potential for the articles to have been interpreted differently.

To minimize the limitations above the author followed the PRISMA based systematic review guidelines and protocol [16, 24]. We filtered the information collected, starting at 479 articles from the PubMed and CINAHL academic databases until there was no additional information available to develop themes. The author then read each article and decided whether or not the article was aligned with the research question. Despite the limitations of this study, the use of mobile apps of AI to treat depression does indeed have the potential to improve patient outcomes.

Future researchers can use the results of this literature review as a basis for possibly conducting a mixed method study. Researchers should consider incorporating data collection processes with qualitative and quantitative surveys to further prove the efficacy using these tools in the mental health field. Also, clinicians can use these results as a basis to develop an implementation plan for the use of AI and mobile apps, in the treatment of their patients with depressive symptoms.

5. CONCLUSION

Technological advances will continue to improve the access and quality of healthcare. Mental healthcare is an excellent application of these state-of-the-art informatics tools. Overall mobile applications and AI technologies for mental health are effective and innovative and will continue to improve the way in which mental health interventions are delivered. The authors suggest that clinicians and administrators forge the way forward and implement these tools into their organization's practices.

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