

Harnessing Digital Health Solutions to Enhance Medication Adherence in Patients With Depression

Victor Okoye¹, Godwin Okoye², Daniel Appiah³

¹Saint Louis University School of Medicine, Saint Louis, MO, USA

²University of Austin at Texas School of Pharmacy, Austin, TX, USA

³Brown School, Washington University in St. Louis, St. Louis, MO, USA

Address correspondence to Victor Okoye (drvictorokoye@gmail.com).

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ABSTRACT

The growth of digital health solutions is rapidly advancing, and mental health care is rapidly changing due to the enormous explosion of digital technology infrastructure and processes. Digital technology is poised to dramatically alter patient care delivery, thanks to the adoption of artificial intelligence, big data, wearable mobile technology, and network information. This review covers the uptake and implementation of digital solutions for medication adherence in major depressive disorder and explores potential barriers to access.

Keywords: digital health, medication adherence, depression, mental health, telehealth, informatics

INTRODUCTION

More than 300 million people worldwide,^[1] including more than 16 million adults in the United States,^[1,2] suffer from depression, a serious public health issue with need for urgent intervention. Due to a variety of circumstances, including simple forgetfulness, depressed patients frequently have trouble remembering to take their prescribed medication. Our goal for this review was to methodically compile all the accessible data on the potential benefit and effectiveness of digital health technologies to improve medication compliance in major depressive disorder (MDD).

MDD places a serious consequence on cognitive mental function of those afflicted,^[3,4] including the possibility of a lowered quality of life and shorter life expectancy.^[5] It also places a significant financial strain on the healthcare systems that care for those affected. The treatment of MDD involves the use of a variety of drugs to improve mood, reduce symptoms that can negatively impact humanistic health outcomes, and treat common comorbid conditions like anxiety and bipolar disorders. Psychotherapy has also proven to be effective in emergency management of MDD.^[6]

Although there are many treatment alternatives,^[6,7] millions of people continue to experience worsening depressive episodes due to nonadherence, which can result in aggravated symptoms and disease relapses.^[8] Digital health solutions have come to light as promising strategies to

assist depression medication adherence.^[9] The methodologies, findings, advancement, potential, and analysis of how digital health can be used to address this important issue are explored in this review.

One of the biggest problems in managing persons with MDD is nonadherence to medication.^[10] The complexity of adherence in this group, the specific inhibitors and enablers of effective adherence behaviors, and the contribution of emerging digital health solutions to closing the gap between evidence-based recommendations and the actual standard of care are all explored in this review. We outline the most recent data supporting the use of digital health technologies among MDD populations, highlighting the important open-ended research topics, and provide useful advice for doctors and healthcare providers on how to encourage medication adherence in this era using digital health.

People with MDD frequently receive complicated prescription^[10] regimens that they must comprehend and take correctly—frequently for up to 6 months and sometimes the rest of their lives.^[10,11] It comes as no surprise that medication adherence, which is measured by how closely patients follow doctor’s orders to take their medications, is subpar and poses a serious clinical difficulty, leading to poorer health outcomes, higher rates of morbidity and mortality, increased hospital readmission, and higher health system costs, which are all linked to lower levels of

Table 1. Search terms used for this study

Database	Search Term	No. of Results	No. of Duplicate Records	Relevant Studies
Medline (PubMed)	("Depression" OR "Depressive Disorder" OR "Major Depressive Disorder" OR "Medication Adherence" OR "Digital Health" OR "Telemedicine") AND ("Mobile Applications" OR "Reminder Systems" OR "Wearable Electronic Devices" OR "Telecommunications" OR "Patient Compliance") AND ("Effectiveness" OR "Outcome Assessment (Health Care)" OR "Treatment Outcome")	2612	841	79
Embase	'Depression'/exp OR 'Major Depression'/exp OR 'Medication Adherence'/exp OR 'Digital Health'/exp OR 'Telemedicine'/exp) AND ('Mobile Application'/exp OR 'Reminder System'/exp OR 'Wearable Electronic Device'/exp OR 'Telecommunication'/exp OR 'Patient Compliance'/exp) AND ('Effectiveness'/exp OR 'Outcome Assessment (Health Care)'/exp OR 'Treatment Outcome'/exp)	1149	472	33

medication adherence.^[12] Investigating novel scientifically supported approaches to enhance drug adherence is therefore a top public health priority, and recent advancements in digital health offer a promising new path for change.

METHODS

Our search strategy included studies from Embase and Medline (PubMed) databases for papers from inception to June 2023, tailored to our review purpose. Search terms were digital health, depression, mental health, wearable technology, reminders, medication adherence, and tele mental health (Table 1). For this review, our search was applied for relevant studies and previous systematic literature reviews. We also included papers from clinicaltrials.gov for randomized controlled trials using wearable technology, mobile phone, telephone texting, or internet (audio and video) to deliver MDD medical information for medication adherence as a major intervention, with severity of depression outcomes as primary and secondary endpoints.

Medication Adherence

Patients with MDD need to take multidrug combinations daily,^[12] which makes it difficult to maximize medication compliance. The intricacy of the drug regimen, symptoms associated with the medications, external factors, and psychological stressors that may be concurrent with or connected to the condition can all make adherence very difficult. Prior suicide attempts, adverse drug reactions, shameful public perception, and poor living conditions are also substantially connected to medication nonadherence in MDD.^[13]

Despite the rapid advancement in drug development, it is still estimated that 40–60% of patients with chronic diseases in affluent countries do not take their medications as prescribed;^[14] 6–9% of people's attitudes toward medication adherence were rigid and binary,^[13,14] with either being adherent or not. However, drug compliance is dynamic and particularly influenced by factors such as

the disease severity, the type of treatment used, and psychological aspects.^[15]

It is well known that certain demographic (e.g., young adult, male), cultural (e.g., non-White ethnicity), and psychosocial (e.g., stress, forgetfulness, poverty, lack of education, social support, and treatment participation) factors increase the risk of patients with MDD engaging in less-than-optimal medication therapy.^[15] Medication forgetfulness continues to be the most common patient-reported cause of poor adherence, suggesting the potential for medication reminders as an important intervention tool. Depending on the clinical situation or stage of MDD, the relative weight of each predictor of nonadherence seems to change.

For instance, although women demonstrated higher nonadherence rates in MDD, men and women exhibit comparable nonadherence rates to serotonin norepinephrine reuptake inhibitors,^[14] the number one prescribed drug class for MDD and other mental health-related diseases. Out-of-pocket expenses also have a considerable and pervasive impact on treatment adherence, affecting people in high-, low-, and middle-income countries,^[15] although out-of-pocket costs have a disproportionately negative effect on low-income households and those without health insurance. Factors such as skipping doctor appointments, and complete treatment avoidance are all correlated with out-of-pocket costs, which negatively affects patient outcomes.^[16]

Advancements in Digital Health

The quick development of digital technology in recent years has created previously unheard-of chances to engage with patients and encourage better health habits like medication adherence.^[17] Researchers have found that patients can reduce the number of times they miss their medication doses by using text message reminders, mobile phone applications, wearable technology, and social platforms.^[18] Presently there is no method for healthcare professionals to verify that the patient took the drug. Digital health treatments have the potential to minimize clinician

Table 2. Digital health solutions and demonstrated adherence efficacy in major depressive disorder

Digital Health Solutions	Findings and Outcomes
Mobile apps	Positive impact on adherence with personalized reminders ^[31]
Wearable devices	Improvement in adherence through continuous monitoring and feedback ^[31]
Telehealth platforms	Enhances patient-provider communication, leading to better adherence ^[32]
Personalization	Tailored interventions correlate with improved medication adherence ^[32]
Communication enhancement	Telemedicine positively influences patient engagement and adherence ^[33]
Addressing barriers	Strategies improve digital literacy and accessibility, boosting adoption ^[33]
Ethical considerations	Privacy-focused interventions build patient trust in digital solutions ^[33]

workload and time,^[18,19] lower patient-related costs associated with clinic and hospital visits, and give access to assistance and education regardless of one's location.^[19] Although digital treatments may target certain patient factors, behaviors linked to poor drug adherence may be targeted by other digital interventions, as not all these factors are controllable. Even while there are growing prospects, there are still many unanswered questions, including which patients will benefit most, which technologies will produce optimal results, and how their use ought to be patient-centric, durable, and cost-effective.

Digital medication adherence may be improved with the following solutions (Table 2).

Mobile health apps

Medication reminders via mobile apps are simple and practical to arrange. To make sure that patients take their prescribed antidepressants as instructed, these apps offer timely notifications to patients.^[19] The ability to measure mood, side effects, and general well-being is another function that many apps offer, enabling users to keep tabs on their progress.

Studies have shown that depression medication adherence can significantly improve with the use of mobile apps.^[19] User-friendly interfaces and frequent reminders have assisted patients in sticking to their drug schedules.

Telehealth

Platforms for telehealth allow people to consult with medical professionals from a distance. This makes it easier for continual communication, allowing medical experts to monitor drug adherence and offer support immediately.^[18,19] The inconveniences of travel and schedule conflicts that come with in-person consultations are also lessened with telemedicine.

Telehealth and telemedicine services have shown an improvement in patient engagement.^[18,20] When patients

can regularly contact their healthcare providers and have easy access to them, they are more likely to comply with their treatment regimens.

Wearable technology

Wearable technology, including fitness trackers and smartwatches, may monitor physiological indications, including heart rate variability, sleep patterns, and physical activity.^[21] A more comprehensive picture of a patient's health and medication adherence can be provided by integrating these data points with digital health platforms.

The treatment of depression may one day be completely transformed thanks to wearable technology.^[20,21] Healthcare professionals can personalize treatment programs and increase their efficacy by collecting and evaluating data on physical activity, sleep quality, and physiological indicators.

Online support communities

Online discussion boards and social media pages for depression and mental health offer a sense of belonging and assistance. Patients can trade advice on adherence techniques and discuss their experiences taking medications, promoting a sense of accountability. Patients can also discuss their problems and victories in online support networks. Having conversations with people who have gone through similar things might give patients the drive to keep taking medicine as prescribed.^[22]

Clinical Trials

A clinical trial investigating the efficacy of digital medication adherence solutions^[23] in individuals with depression demonstrated promising results. The trial, conducted over a span of 12 months, used a randomized controlled design with participants using a mobile application designed to provide medication reminders, educational resources, and personalized feedback. The intervention group exhibited a statistically significant improvement in medication adherence rates compared with the control group, as measured by electronic pill bottle monitoring and self-reported data. Furthermore, the trial indicated a positive association between sustained medication adherence and symptomatic improvement in depression scores. The real-world impact of digital medication adherence solutions, extrapolated from the trial's findings, suggests that integrating such technologies into routine clinical practice has the potential to enhance treatment outcomes by addressing a critical barrier to effective depression management^[23,24]: medication nonadherence. As these digital solutions are increasingly accessible and user-friendly, their adoption in real-world settings holds promise for improving patient engagement, fostering better communication between patients and healthcare providers, and ultimately optimizing the overall quality of care in depression treatment.

Personalized Approaches

Personalized approaches in digital solutions play a pivotal role in improving medication adherence^[24] by addressing the unique needs and preferences of individuals. Tailoring interventions to suit the specific characteristics, lifestyles, and challenges of each patient can enhance engagement and motivation, crucial factors in fostering sustained medication adherence. Digital solutions, such as mobile applications or wearable devices,^[25] allow for customization based on a person's medication schedule, reminders, and even preferences in communication styles. By considering individual differences, these technologies can provide personalized educational content, behavioral prompts, and positive reinforcement, creating a more patient-centric experience.^[26] This individualized approach acknowledges the diverse factors influencing medication adherence, including socioeconomic conditions, psychological factors, and daily routines. As a result, tailoring interventions through digital solutions not only addresses barriers to adherence on a personal level but also contributes to a more effective and patient-friendly strategy for managing depression and other mental health conditions.^[27]

Challenges of Digital Health Integration

At the patient, physician, and health system levels, there are risks and problems associated with digital health interventions that need to be considered and mitigated. At the patient level, confidentiality breaches must be avoided, which calls for careful data management practices.^[28] Interventions may also carry a slight risk of injury because general health messaging is frequently communicated in a restricted number of words and with a limited amount of context, which raises the probability of safety difficulties. The increased use of digital health technology may potentially disadvantage patients who lack access, are uneducated, and experience some form of health inequality,^[29] known as the “digital divide.”

Clinician adoption of digital health may be hindered by various factors, including a lack of training and familiarity with digital tools,^[30] time constraints in busy clinical settings,^[30] concerns about disrupting existing workflows, worries about compromised patient-clinician interactions,^[30] and data security and privacy issues. Financial barriers, resistance to change, interoperability challenges, and the need to navigate complex regulatory compliance further contribute to the hesitancy among clinicians. There are financial barriers for the patient as well in terms of accessing medications.

Successful integration of digital health into clinical practice requires addressing these concerns through comprehensive training programs, user-friendly solutions that align with existing workflows, and collaborative efforts among technology developers, healthcare institutions, and regulatory bodies to create a supportive and conducive environment for adoption.

Recommendations to overcome these challenges include the following:

- Use simple medication dosing schedules when possible.
- Employ teach-back approaches to ensure that patients understand pharmaceutical instructions.
- Examine and evaluate patient-focused mobile phone applications that are currently available, such as NPS MedicineWise,^[30] and suggest applications that patients may find helpful.
- Encourage patients to see their pharmacist before using a single digitalized medication list. Some pharmacies additionally have software that manages prescription refills and drug lists.
- Examine the potential for real-time monitoring of medication compliance using data from the electronic medical record.

Additional Barriers to Digital Health

The widespread adoption of digital solutions in health-care, particularly in the context of mental health and medication adherence, is hindered by several potential barriers that need acknowledgment. One significant challenge is the issue of access,^[31] where disparities in technology availability and internet connectivity exist across different populations. Individuals in economically disadvantaged or remote areas may face limited access to smartphones, computers, or a stable internet connection, impeding their ability to use digital health solutions effectively.

Digital literacy is another crucial factor influencing adoption,^[31,32] Some individuals, particularly older adults and those with limited exposure to technology, may struggle with navigating complex digital interfaces or understanding the functionalities of health-related apps. This lack of digital literacy can hinder the successful implementation and utilization of digital solutions for medication adherence. Adherence is greatly influenced by a person's educational level, which represents the social and cognitive skills that influence an individual's drive and ability to get, understand, and use knowledge to promote and maintain health.^[33] Low health literacy which is estimated to affect 25% of people with MDD,^[34] is linked to nonadherence to medicine, a faster decline in cognitive function, and greater suicide rates.^[33]

Resistance to technology, often rooted in concerns about privacy, security, or a general discomfort with the use of digital tools in healthcare, poses a significant barrier.^[33] Patients may fear the misuse of personal health data or have concerns about the reliability of digital interventions. Building trust and addressing privacy concerns are essential steps to overcoming this resistance.

Moreover, healthcare providers' hesitancy or lack of training in incorporating digital solutions^[27] into their practice can impede adoption. Some may perceive the integration of technology as an additional burden or may lack the necessary knowledge to guide patients effectively in using these tools.

To address these barriers, it is crucial to implement strategies that enhance digital inclusion, such as initiatives to improve access to technology in underserved communities, providing digital literacy training programs,^[32,33] and fostering awareness about the benefits and security measures associated with digital health solutions. Collaborative efforts among healthcare providers, policymakers, and technology developers are essential to overcome these challenges and ensure that the benefits of digital solutions in mental health are accessible to a diverse range of individuals.

CONCLUSION

Digital health solutions are transforming the landscape of depression treatment by addressing the critical issue of medication adherence. The methods discussed, including mobile apps, telehealth, wearable devices, and online support communities, are yielding positive results and improving the lives of individuals living with depression. As technology continues to advance, the integration of digital health into depression care promises to be a valuable tool in enhancing medication adherence, reducing relapse rates, and ultimately improving the overall well-being of patients. However, it is essential to remain vigilant in addressing issues related to data privacy, accessibility, and equity to ensure that all individuals can benefit from these innovations in mental healthcare.

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