Technology in Mental Health Treatment: A Review of Teletherapy, Mobile Health Apps, Virtual Reality, and Artificial Intelligence

Rafal Lenartowicz
Oregon State University

Abstract

This article provides a comprehensive review of the use of technology in mental health treatment, focusing on teletherapy, mobile health apps, virtual reality, and artificial intelligence. The review examines the effectiveness, benefits, and limitations of each technology and highlights the implications for future research. The findings demonstrate that teletherapy enhances access to mental health services, mobile health apps offer convenience and support, virtual reality interventions show promise in reducing stress and anxiety, and artificial intelligence aids in diagnosing and understanding mental disorders. However, further research is needed to assess long-term effectiveness, address privacy concerns, and enhance app content quality.

Keywords: technology, mental health treatment, teletherapy, mobile health apps, virtual reality, artificial intelligence

Introduction

Mental health disorders represent a significant public health concern. According to the World Health Organization, approximately one billion people worldwide suffer from some form of mental disorder (World Health Organization, 2022). Despite the high prevalence and potentially debilitating impact of these conditions, access to effective mental health treatment remains inadequate for many individuals. Barriers to access include geographical distance, cost, and stigma associated with seeking mental health care (Coombs et al., 2021).

In recent years, technology has emerged as a promising tool for overcoming these barriers and augmenting traditional mental health treatments. The use of technology in mental health care, often referred to as digital mental health, encompasses a wide range of applications, from teletherapy and mobile health (mHealth) apps to more advanced technologies such as virtual reality (VR) and artificial intelligence (AI) (Torous et al., 2021).

Teletherapy allows mental health professionals to provide services remotely via videoconferencing, increasing access for those who may be geographically isolated or otherwise unable to attend in-person therapy

(Arafat, Zaman, & Hawlader, 2021). Similarly, mHealth apps can offer therapeutic techniques, psychoeducation, and self-monitoring tools directly to users' smartphones (Diano, Sica, & Ponticorvo, 2023). In a more immersive approach, VR has been used to provide exposure therapy for conditions such as post-traumatic stress disorder and specific phobias (Maples-Keller et al., 2017). Meanwhile, AI has potential applications in mental health diagnosis, treatment personalization, and predictive analytics (Graham et al., 2019).

Despite the rapid proliferation of these technologies, their effectiveness as mental health interventions is still a matter of ongoing research. Furthermore, each technology presents unique challenges and ethical considerations, from ensuring privacy and confidentiality in teletherapy and mHealth apps to addressing the potential psychological risks of VR and the algorithmic biases of AI (De Witte et al., 2021). Similarly, virtual reality (VR) brings forth challenges related to potential psychological risks, such as cybersickness, disorientation, or triggering of traumatic experiences (Lundin, Yeap, & Menkes, 2023). It is crucial to develop safeguards and guidelines to minimize these risks and ensure user safety. Additionally, the use of artificial intelligence (AI) raises concerns about algorithmic biases that may inadvertently perpetuate social inequalities or discriminatory practices. Efforts should be made to address these biases and promote transparency, fairness, and accountability in AI algorithms used in mental health treatment.

The review aims to provide an overview of the current state of research on the use of teletherapy, mHealth apps, virtual reality (VR), and artificial intelligence (AI) in mental health treatment. It intends to evaluate the evidence for the effectiveness of each technology, discuss their potential benefits and limitations, and suggest directions for future research.

Methods

This literature review aims to investigate the range of technologies implemented in mental health treatment, as well as their effectiveness. The research methodology entails a systematic search of academic literature published within a particular time frame (2017-2023). This period was chosen to ensure that the review focuses on technologies that are currently relevant to the field of mental health treatment.

A comprehensive search was carried out on databases such as PubMed, IEEE Xplore, and Google Scholar. The scope of the search was further expanded by manually inspecting the reference lists of identified studies to discover additional relevant articles. This is a review article that synthesizes findings from other research articles within the specified area of interest.

The inclusion and exclusion criteria for studies were:

Inclusion criteria	Exclusion criteria

Studies involved technology-based interventions for mental health treatment	Studies that did not involve a technology-based intervention
Studies evaluated efficacy through RCTs, longitudinal studies, or meta-analyses	Studies that did not assess effectiveness
Studies published in English	Studies not published in English
Studies published in peer-reviewed journals	Studies not published in peer-reviewed journals

Figure 1. Criteria used for selection of the materials

This approach ensured a comprehensive and organized review of the various technologies involved in mental health treatment and their efficacy. The findings provide a strong basis for understanding the current landscape of technology use in mental health treatment and the areas that need further research.

Technologies Used in Mental Health Treatment

Teletherapy

The COVID-19 pandemic, along with its consequential societal changes, catalyzed an increased reliance on telemental health services, also known as teletherapy (Mazziotti & Rutigliano, 2021). This mode of mental health care, using electronic communication like videoconferencing, telephone calls, and mobile apps, has demonstrated significant efficacy over two decades (Gangamma et al., 2022). The pandemic underscored its importance as a flexible and accessible tool, particularly for underserved populations. Even as we move beyond pandemic restrictions, teletherapy's future looks promising, but challenges around equitable access, ongoing training needs, and technological advances persist (Ftouni et al., 2022).

In a real-world observational study by Shih et al., (Shih et al., 2022) the effectiveness of different care modalities (limited, text-based coaching, clinical, and hybrid care) in treating depression and anxiety was examined. It was observed that approximately 40% of participants showed a full response to treatment across the different care modalities. Notably, the study found no significant difference in treatment responses among text-based coaching, clinical care, and hybrid care, thus suggesting the potential for equal effectiveness of these approaches (Shih et al., 2022). Although higher usage generally led to better outcomes in most modalities, the results were consistent across all usage levels in the hybrid care group. These findings highlight the promising role of digital behavioral health interventions and particularly text-based coaching in mental health treatment.

Another study by Feusener et al reveals significant improvements in obsessive-compulsive disorder (OCD) symptoms among patients treated with digital Exposure and Response Prevention (ERP) teletherapy. Approximately 62.9% of patients were classified as full responders, exhibiting a 43.4% reduction in OCD symptoms, and enhanced quality of life. Comorbid symptoms of depression, anxiety, and stress also showed significant improvement. The results were achieved within 12 weeks, with

less than 11 total therapist hours on average, suggesting cost and time savings (Feusner et al., 2022). The study highlights that this treatment model is as effective as traditional face-to-face therapy while providing benefits such as reaching patients in remote locations and continual support through messaging and web-based community. However, the results should be seen in light of certain limitations, such as lack of follow-up data for many patients, and treatment flexibility (Feusner et al., 2022).

Telemedicine has been demonstrated to be a viable and acceptable method for delivering a range of healthcare services, including psychotherapy. Its advantages extend beyond bridging geographical gaps, offering specialist support in various medical fields. However, the global implementation of telemedicine requires standardized laws and assurances regarding data privacy. Professionals need adequate training in telemedicine, and outdated or absent legislation remains a challenge. Ethical considerations and costs are central to the discourse, emphasizing patient confidentiality and the informed consent process (Nittari et al., 2020).

Teletherapy offers immense potential for expanding access to mental health services, particularly in remote or underserved areas. As technology advances, new methods of delivery, such as AI-powered interventions or immersive VR experiences, could be developed to further enhance treatment efficacy. However, this progress depends on overcoming challenges like establishing robust data privacy protections, standardizing regulations, and ensuring equitable access. Ongoing professional development and training in teletherapy techniques is also essential. Future success will rely heavily on striking a balance between technological innovation and ethical healthcare practices.

Mobile Health Apps
The ubiquity and functionality of smartphones have significantly increased, presenting a potent avenue for delivering healthcare services to the broader population. The profusion of health-related apps available for download today attests to their widespread acceptance. Presently, many smartphones are capable of passively gathering diverse health information, including patterns of physical activity, social engagement, sleep, and mobility, and deducing mental and physical health insights (Milne-Ives et al., 2020).

One important meta-analysis investigated the effectiveness of smartphone-supported psychological interventions in reducing anxiety symptoms, utilizing nine Randomized Control Trials (RCTs) with a total of 1837 participants (Firth et al., 2017). The study found these interventions significantly reduced anxiety symptoms compared to control conditions. Greatest benefits were observed when smartphone interventions were compared to waitlist control conditions, though reduced effects were noted when compared to active controls. Stand-alone smartphone interventions that directly targeted anxiety didn't demonstrate significant benefits, but benefits were found when smartphone elements were integrated within broader therapeutic interventions. Therefore, while smartphones show promise in managing anxiety, they seem most effective

when augmenting traditional therapies. Concerns around the 'digital placebo effect', a perceived symptom improvement or enhanced well-being resulting from engaging with digital interventions, even without specific therapeutic elements (Torous & Firth, 2016) were observed. The study points that more research is required to understand the factors influencing intervention outcomes and to explore the relative efficacy of smartphone-only versus face-to-face interventions for anxiety.

Another worth-mentioning study conducted a usability analysis of BlueWatch, an intervention app for depression, using feedback from end users, clinicians, and mental health researchers (Fuller-Tyszkiewicz et al., 2018). The analysis found that all groups agreed that BlueWatch had an appealing layout, was engaging, and offered a range of evidence-based strategies for addressing depressive symptoms. Users liked the mood monitoring feature and personalization of content. However, experts raised concerns about the absence of therapist contact, indicating that it was unclear if participants were using the app content correctly. One user suggested an interactive journaling feature that could provide feedback, to simulate a therapist interaction. It was noted that perceptions of the app's usability could have been affected by differences in age and experience with the app. The study emphasizes the importance of incorporating end-user perspectives in usability testing and suggests that further investigation is required to fully evaluate usage and efficacy (Fuller-Tyszkiewicz et al., 2018).

The study by Bry et al. revealed that most consumer-marketed mental health apps, particularly for youth anxiety, incorporate minimal evidence-based treatment content, raising concerns about their quality. Given the high prevalence and impact of youth anxiety disorders and the digital connectivity of today's youth approximating 100% (Pew Research Center, 2021), effective self-management of anxiety symptoms via mobile platforms has significant public health potential. However, most accessible apps have relatively basic functionality and do not utilize advanced data collection and intervention strategies, despite the existence of higher quality apps in research settings and the private sector. These superior self-management apps with evidence-based treatment components are not readily visible to consumers, limiting their reach. The study underscores the need for future mHealth initiatives to boost the visibility and accessibility of high-quality interventions in the consumer marketplace (Bry et al., 2018).

Smartphones' increased ubiquity and functionality offer an promising avenue for delivering health services. Studies found that smartphone interventions can reduce anxiety symptoms, especially when supplementing traditional therapies, and provide usable, engaging strategies for addressing depression symptoms. However, most consumer-marketed mental health apps lack evidence-based content, particularly for youth anxiety. As it can be concluded from the view of Chandrashekar (2018) mobile apps offer promising solutions to the global mental health treatment gap, but their full potential can only be realized through integrated efforts in science, regulation, and design.

Virtual Reality

Virtual reality, as conceptualized by pioneers like Sutherland and Krueger, refers to an interactive, immersive environment that is designed to simulate the real world in real-time. This simulation is realistic enough to offer sensory experiences and allows the user to manipulate the environment directly (Sutherland, 1970; Krueger, 1993). In mental health therapy, Virtual Reality (VR) is a powerful technological tool that creates immersive, 3D environments for targeted therapeutic interventions. By integrating VR with advanced graphics cards, position trackers, and head-mounted displays, it facilitates effective treatments for various mental disorders (Liu et al., 2022).

In the study by Lin et al. (2020), the effects of Virtual Reality-based Music Therapy in reducing anxiety and stress were examined. The study described a VR-based Musical Therapy system that followed Cognitive Behavioral Therapy principles and incorporated elements of traditional music therapy. Cognitive behavioral therapy is a form of psychotherapy that focuses on identifying and changing negative thought patterns and behaviors to promote mental health and well-being (APA Div. 12 (Society of Clinical Psychology), 2017). The system offered two primary modes of operation: receptive and active. In the receptive mode, users could choose from prerecorded 360 panoramic videos as backgrounds and select accompanying music, creating an immersive and peaceful environment. The active mode allowed users to play virtual musical instruments to express their feelings and emotions. The system utilized a head-mounted display and hand-tracking control for user interaction (Lin et al., 2020).

The Lin et al. study involved 19 participants (16 males, 3 females) and found that VR-based music therapy significantly reduced stress levels, with an average reduction of around 32%. Most participants reported lower stress after the therapy, despite some experiencing mild motion sickness from the VR technology. One participant, with a history of severe vertigo, reported increased stress due to the VR headset. Yet, all expressed interest in future participation. The results suggest that the combination of music and VR can provide a potent tool for stress reduction, though improvements in the user interface and mitigation of VR-induced motion sickness are needed (Lin et al., 2020).

In another study conducted by Taneja et al., the use of Virtual Reality Therapy (VRT) as a means to reduce mental stress, particularly among students, was examined. The study used a Virtual Environment (VE) paired with calming instrumental music to immerse the participant and foster relaxation (Taneja et al., 2017). The participant's immersion was further enhanced by conducting the therapy in a dark, sound-proof room. This approach according to Taneja et al. was an attempt to make Cognitive Behavioral Therapy (CBT) more immersive using advanced virtual reality technology.

The study highlighted that the immersive nature of VRT makes it an ideal therapeutic technique for reducing mental stress (Taneja et al., 2017). The effectiveness of VRT in reducing stress was psychologically perceived by participants from the first session. However, the Visual Go Nogo task according to Taneja et al. was not suitable for evaluating stress therapy. The Go/No-Go task is a test where participants react quickly to 'Go' stimuli, resist responding to 'No-Go' trials, assessing response

inhibition, attention diversion, and reward impacts (Scalzo et al., 2016). Future research, according to the authors, should focus on analyzing the effectiveness of VRT using physiological parameters such as Electroencephalography (EEG), Heart Rate Variability (HRV), and Respiration Rate to further investigate its benefits in reducing mental stress (Taneja et al., 2017).

Studies by Lin et al. (2020) and Taneja et al. (2017) indicate the efficacy of Virtual Reality (VR) in reducing stress and anxiety, especially when coupled with music therapy and Cognitive Behavioral Therapy (CBT). However, motion sickness from VR and unsuitability of certain cognitive tasks, like the Go/No-Go task, in assessing therapy effectiveness were challenges encountered. These highlight the need for user interface improvements and a more comprehensive assessment tool. Going forward, the use of physiological parameters such as EEG, HRV, and Respiration Rate should be explored to the understanding of VR's therapeutic potential in mental health.

Artificial Intelligence
Artificial Intelligence (AI), a term introduced by John McCarthy in 1955, refers to the scientific and engineering domain focused on the creation of intelligent machines (Manning, 2022). Intelligence, in this context, implies the capacity to learn and implement a variety of strategies for problem-solving and goal achievement, mirroring human adaptability in an uncertain and constantly changing world. Contemporary AI emphasizes the development of agents capable of learning autonomously, thereby navigating and adapting to alterations in their environment (Manning, 2022).

Artificial Intelligence (AI) has considerable potential in diagnosing and understanding mental disorders by offering pre-diagnostic tools and risk models. Deep learning methods have achieved over 90% accuracy in distinguishing depressive patients from healthy controls, using EEG (Liu, Pu, et al., 2022). AI-supported virtual psychotherapeutic devices, such as chatbots, can help identify emotions and thought patterns and teach coping skills, effectively reducing depressive symptoms (Liu, Huaming, et al., 2022). Machine learning algorithms have been used in studies to differentiate patients with psychotic disorders from healthy ones and aid the treatment of schizophrenia using virtual avatar therapy (Hudon et al., 2023). AI has also proven successful in treating child and adolescent disorders like ADHD and Autism Spectrum Disorder (Barua et al., 2022).

Due to the limited scope of this article, it is not feasible to comprehensively review all existing studies and research pertaining to the application of Artificial Intelligence in mental health. Nevertheless, it is important to acknowledge that there are relevant studies that could contribute valuable insights to this article. An illustrative example is the study conducted by Katarya and Maan, focusing on the employment of data from the 2019 mental health survey of tech and non-tech company employees. The study applies various machine learning algorithms to identify personal and professional factors that impact employees' mental health and aims to construct the most accurate predictive model for their mental health status (Katarya & Maan, 2020).

The paper applies several machine learning methods, all within a supervised learning framework given the labeled dataset. Techniques include Support Vector Machine (SVM) that uses a hyperplane to segregate data classes, Logistic Regression with a sigmoid function for binary predictions, and K-Nearest Neighbours (KNN) that classifies based on the majority class of 'k' nearest data points. Decision Trees identify key features contributing to mental health disorders, while the ensemble-based Random Forest model boosts accuracy. Lastly, the probability-based Naïve Bayes classifier is utilized (Katarya & Maan, 2020).

The study of Katarya and Maan showed that the decision tree classifier demonstrated the best performance, achieving an accuracy of 84% and precision of 83%. Logistic regression followed closely with 84% accuracy and 82% precision. Naïve Bayes, random forest, SVM, and KNN yielded lower accuracy and precision scores. Feature importance analysis revealed that a history of mental health disorder had the most significant contribution to the prediction, followed by family history. Other features, including gender, mental health benefits, age, and discussing mental health status with the employer, had minimal impact (Katarya & Maan, 2020).

According to the authors future directions include exploring deep learning and hybrid classifiers to improve accuracy, consulting psychiatrists for refined feature selection, and using the selected features to enhance HR practices and provide mental health support to employees (Katarya & Maan, 2020).

Although relatively recent, the widely recognized chatbot, ChatGPT, merits inclusion in this review, at least in a concise capacity. Artificial intelligence, including chatbots like ChatGPT, are experiencing increasing use in mental healthcare, but concerns persist about its reliability and application. While it provides detailed, humanlike responses, potentially useful in medical writing and education, it hasn't been trained on specialized medical data, leading to potential inaccuracies (Chow, Sanders, & Li, 2023). This raises issues regarding patient safety and the potential for misinformation. The technology also faces ethical concerns like privacy and cybersecurity (Chow, Sanders, & Li, 2023). Despite these obstacles, ChatGPT, as a disruptive technology, has the potential to revolutionize how we interact with technology in healthcare. It might offer more efficiency, reduce medical errors, and help doctors perform better, but it requires constant fine-tuning and verification by medical professionals (Chow, Sanders, & Li, 2023). Rapid advancements in AI will continuously modify the ethical framework, necessitating continuous reevaluation (Chow, Sanders, & Li, 2023). While the chatbot is popular and user-friendly, it is crucial for both medical providers and patients to use it ethically and with caution (Chow, Sanders, & Li, 2023). Even though ChatGPT isn't perfect as a medical chatbot yet, it is expected to transform healthcare systems in the near future, given proper handling of existing obstacles (Chow, Sanders, & Li, 2023). Collaboration between developers, medical experts, and stakeholders is needed to ensure this tool's safe and effective use (Chow, Sanders, & Li, 2023).

In summary, the application of Artificial Intelligence (AI) in mental health, including AI-supported virtual psychotherapeutic devices, machine learning algorithms, and deep learning, is demonstrating promising

potential. Advances in AI have been significant in diagnosing mental disorders, differentiating patients from healthy controls, and aiding in the treatment of various conditions like depression, schizophrenia, and child and adolescent disorders. The study by Katarya and Maan (2020) elucidates the potential of machine learning algorithms in predicting mental health status based on personal and professional factors. Despite these advancements, concerns persist about the reliability and application of AI tools, as exemplified by the chatbot ChatGPT, which faces issues of accuracy, patient safety, privacy, and ethics. Future advancements in AI are expected to refine these tools and their applications, making them safer and more effective with collaborative efforts from developers, medical experts, and stakeholders.

Discussion

The use of technology in mental health treatment has gained significant attention in recent years, offering potential solutions to overcome barriers and enhance traditional approaches (Torous et al., 2021). Teletherapy has emerged as a valuable tool for increasing access to mental health services, particularly for individuals who are geographically isolated or face other limitations (Arafat, Zaman, & Hawlader, 2021). Studies have shown the effectiveness of teletherapy in treating various mental health conditions, including depression and anxiety (Shih et al., 2022). Additionally, digital exposure and response prevention teletherapy have demonstrated positive outcomes in reducing symptoms of obsessive-compulsive disorder (Feusner et al., 2022). However, challenges such as data privacy and legislation surrounding telemedicine need to be addressed to ensure its widespread implementation (Nittari et al., 2020).

Mobile health apps offer a convenient and accessible platform for delivering mental health interventions directly to users' smartphones (Diano, Sica, & Ponticorvo, 2023). These apps have been found effective in reducing anxiety symptoms, especially when integrated with traditional therapies (Firth et al., 2017). Usability studies have shown positive user feedback regarding the layout, engagement, and evidence-based strategies provided by these apps (Fuller-Tyszkiewicz et al., 2018). However, concerns have been raised about the lack of evidence-based content in many consumer-marketed apps, particularly for youth anxiety (Bry et al., 2018). Efforts should be made to enhance the visibility and accessibility of high-quality interventions in the consumer marketplace (Bry et al., 2018).

Virtual reality (VR) offers an immersive and interactive environment for therapeutic interventions (Liu et al., 2022). VR-based interventions, such as virtual music therapy, have shown promise in reducing stress and anxiety (Lin et al., 2020). However, challenges related to motion sickness and the suitability of cognitive tasks for assessing therapy effectiveness need to be addressed (Lin et al., 2020; Taneja et al., 2017). Further research should explore the use of physiological parameters to better understand the benefits of VR in mental health (Taneja et al., 2017).

Artificial intelligence (AI) holds potential in diagnosing and understanding mental disorders through pre-diagnostic tools and risk models (Liu, Pu, et al., 2022). Machine learning algorithms have shown promising results in distinguishing depressive patients from healthy

controls and aiding in the treatment of various conditions (Hudon et al., 2023; Barua et al., 2022). However, concerns regarding the reliability, privacy, and ethical considerations of AI tools, such as chatbots, persist (Chow, Sanders, & Li, 2023). Collaborative efforts between developers, medical experts, and stakeholders are crucial to ensure the safe and effective use of AI in mental health (Chow, Sanders, & Li, 2023).

In summary, teletherapy, mobile health apps, virtual reality, and artificial intelligence offer promising avenues for improving mental health treatment. They have demonstrated effectiveness in increasing access, reducing symptoms, and providing innovative therapeutic approaches. However, further research is needed to evaluate their long-term effectiveness, ensure privacy and ethical considerations, and enhance content quality in consumer-marketed apps. Continued collaboration and development in these areas will contribute to maximizing the potential benefits of technology in mental health care (Shih et al., 2022; Feusner et al., 2022; Firth et al., 2017; Fuller-Tyszkiewicz et al., 2018; Bry et al., 2018; Lin et al., 2020; Taneja et al., 2017; Liu, Pu, et al., 2022; Hudon et al., 2023; Barua et al., 2022; Chow, Sanders, & Li, 2023).

Conclusion

In conclusion, technology in mental health treatment, including teletherapy, mobile health apps, virtual reality, and artificial intelligence, holds promise for improving access and reducing symptoms. Teletherapy increases accessibility, while mobile health apps provide convenience. Virtual reality interventions show potential in reducing stress and anxiety. Artificial intelligence aids in diagnosing and understanding mental disorders. However, further research is needed to assess long-term effectiveness, address privacy concerns, and enhance app content quality. Collaboration and development in these areas will maximize the benefits of technology in mental health care.

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