
Digital Mental Health Technologies: A Survey

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Abstract

Digital mental health, a burgeoning field, integrates technologies such as artificial intelligence (AI), virtual reality (VR), teletherapy, digital therapeutics, and mental health apps to enhance mental health care delivery. This survey examines the current landscape, highlighting the transformative potential of these technologies in providing scalable, personalized interventions. AI's role in offering predictive analytics and personalized insights is pivotal, yet challenges such as data privacy and algorithmic bias persist. VR offers immersive therapeutic experiences, though issues like cybersickness need addressing. Teletherapy has risen significantly, especially during COVID-19, providing remote access but facing challenges in maintaining therapeutic alliances. Digital therapeutics demonstrate efficacy in delivering evidence-based interventions, though integration into traditional care requires addressing reimbursement and training barriers. Mental health apps, leveraging mobile sensing and predictive analytics, enhance self-guided management, yet ethical and regulatory considerations remain critical. The survey underscores the importance of culturally sensitive, user-centric approaches to overcome technological, cultural, and socioeconomic barriers. Future directions include enhancing AI explainability, integrating decentralized technologies, and conducting rigorous trials to validate digital interventions. By addressing these challenges, digital mental health technologies can significantly improve accessibility, personalization, and outcomes in mental health care, especially for underserved populations.

1 Introduction

1.1 Conceptualizing Digital Mental Health

Digital mental health encompasses a range of digital tools and services designed to enhance mental health care delivery and outcomes [1]. This field integrates technologies such as Artificial Intelligence (AI), Virtual Reality (VR), and digital therapeutics, which are increasingly relevant in the context of the metaverse's immersive nature [2]. These technologies enable the provision of personalized support systems to meet individual needs, addressing the growing demand for online mental health resources [3].

Digital mental health interventions (DMHIs) aim to scale evidence-based treatments (EBTs) and bridge the gap between mental health resources and population needs [4]. These include Internet-based platforms, smartphone applications, and mixed reality environments that contribute to innovative mental health solutions [5]. The integration of AI enhances communication and interaction in mental health care, aiding in the diagnosis of conditions such as autism spectrum disorder (ASD) through the analysis of social media data.

Moreover, digital mental health emphasizes user control over data collection and usage, granting individuals agency over their personal information [1]. This approach not only redefines therapeutic interactions but also introduces concepts like self-identification in intelligent agents, expanding mental health services beyond traditional settings [6]. Thus, digital mental health emerges as a multifaceted domain poised to revolutionize mental health care through innovative solutions and clinical strategies.

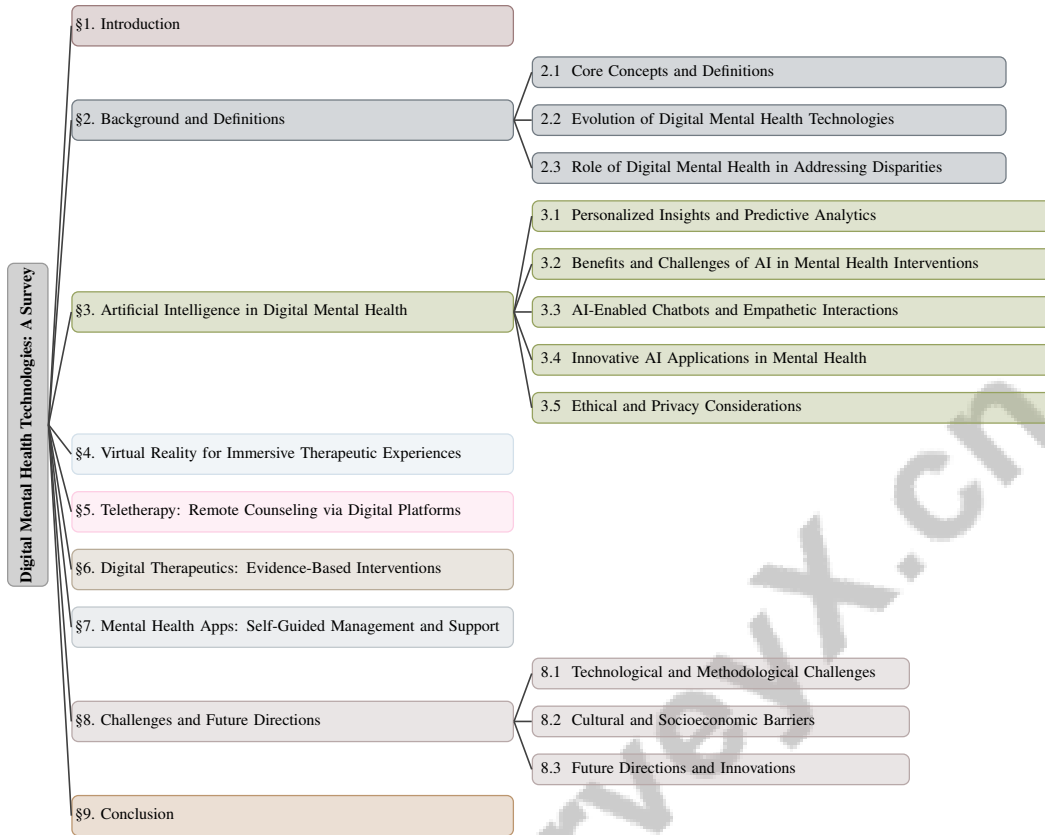


Figure 1: chapter structure

1.2 Significance in Contemporary Mental Health Care

The integration of digital mental health technologies into contemporary care is crucial for addressing societal needs and individual barriers to access. These technologies have proven effective in delivering timely mental health interventions, especially during global crises like the COVID-19 pandemic [5]. By leveraging digital platforms, these interventions enhance accessibility to mental health services, overcoming geographical and logistical challenges that often hinder care, particularly in marginalized communities.

DMHIs hold significant promise for improving mental health outcomes, particularly among young people, and can be integrated into public health strategies to mitigate inadequate access to care [7]. The adaptability of foundation models (HFMs) that integrate diverse data types further enhances diagnostic accuracy and patient care, improving overall mental health service effectiveness. The application of AI, VR, and augmented reality (AR) not only streamlines therapeutic processes but also fosters patient engagement.

However, challenges such as insufficient patient engagement with DMHIs in real-world settings persist, warranting further investigation into the factors influencing this engagement and the identification of research gaps. Implementing a consent-forward paradigm is vital for building trust and safeguarding users, thereby cultivating a secure and effective digital mental health ecosystem. This survey highlights the transformative potential of digital mental health technologies in modern practices, emphasizing their roles in enhancing access, personalization, and mental health outcomes [8].

1.3 Structure of the Survey

This survey offers a comprehensive overview of digital mental health technologies, organized into thematic sections that reflect the core components of this evolving field. The framework follows a five-act categorization system: Access, Quality, Equity and Engagement, Mainstreaming, and Population

Impact [9]. Each section addresses specific goals and challenges inherent in the integration of digital mental health innovations.

The survey begins by outlining essential concepts in digital mental health, including definitions of key technologies such as web-based platforms and mobile applications, and their critical roles in enhancing access to care and addressing disparities. It highlights the efficacy of these technologies in randomized controlled trials while addressing significant implementation challenges in clinical settings, emphasizing the need for innovative strategies and organizational change for sustainable integration [10, 11]. This is followed by a discussion on the historical evolution of digital mental health technologies and their role in addressing disparities.

Subsequent sections delve into specific technologies, starting with AI and its applications in providing personalized insights and predictive analytics. The survey evaluates the benefits and challenges of AI, including AI-enabled chatbots and ethical considerations.

The exploration of VR includes its application in creating immersive therapeutic experiences, revitalizing oral storytelling traditions through personalized narratives, enhancing interpersonal effectiveness in learning environments, and integrating AI to boost user engagement and cultural learning interest [12, 13, 14, 15]. The impact of COVID-19 on VR adoption and the challenges of cybersickness are also analyzed.

Following this, the survey addresses teletherapy, discussing its rise, advantages, challenges, and the importance of maintaining a digital therapeutic alliance. Significant privacy and security issues linked to teletherapy platforms are emphasized, particularly regarding data collection practices that may compromise user confidentiality and compliance with regulations such as the General Data Protection Regulation (GDPR) [16, 17, 18, 10, 19].

The role of digital therapeutics is analyzed, focusing on efficacy, implementation strategies, and integration into traditional mental health care. Cultural sensitivity and the development of tailored interventions are crucial for effectively addressing mental health disparities among marginalized populations, including racial and ethnic minorities, rural communities, individuals experiencing homelessness, and sexual and gender minorities [7, 5].

The survey examines mental health apps, focusing on accessibility for diverse populations, user engagement strategies, and the integration of mobile sensing technologies that track user behavior and mental health indicators to improve the effectiveness of digital mental health interventions [20, 21, 22, 10, 23]. Ethical and regulatory considerations in app development are also addressed.

Finally, the survey identifies key challenges and future directions for digital mental health technologies, exploring technological, methodological, cultural, and socioeconomic barriers. It highlights critical themes such as the necessity for creative clinical implementation strategies, the importance of transdiagnostic approaches, and the need for standardized guidelines to enhance evidence synthesis. The conclusion synthesizes key findings and discusses their implications for advancing digital mental health interventions, particularly in addressing access barriers and improving user engagement while emphasizing ethical data practices and user consent in shaping the future landscape of mental health care [10, 5, 11, 1]. The following sections are organized as shown in Figure 1.

2 Background and Definitions

2.1 Core Concepts and Definitions

Digital mental health incorporates technologies such as AI, VR, teletherapy, digital therapeutics, and mental health applications to enhance care delivery. AI, encompassing ML and DL, significantly aids in diagnosing conditions like autism spectrum disorder and refining human-AI interactions, albeit with ethical and governance challenges [24]. The capabilities of AI are further expanded by large language models (LLMs) that facilitate novel mental health assessments and interventions [25]. However, effective annotation of physiological signal-based emotion data remains a challenge [26]. VR, often integrated with AI, creates immersive environments that enhance interpersonal skills and therapeutic interventions, boosting user engagement and treatment efficacy.

Teletherapy offers remote counseling services, effectively overcoming geographical barriers, particularly highlighted during the COVID-19 pandemic [27]. Digital therapeutics provide evidence-based interventions through software, addressing treatment gaps and offering scalable solutions, especially

in LMICs where stigma and resource limitations hinder access. Mental health apps facilitate self-guided management, employing digital phenotyping and personal sensing to monitor mental health through behavioral data [28].

Technologies like blockchain and federated learning enhance data security and privacy in decentralized healthcare systems [29]. Informed consent and user agency principles are crucial, ensuring individuals maintain control over their personal data within digital platforms [1]. Collectively, these technologies aim to bridge the gap between controlled setting efficacy and real-world application, contributing to the evolution of digital mental health [10]. The exploration of self-identification in intelligent agents, using psychoanalysis and active inference, underscores AI's potential to adapt and learn in complex environments.

2.2 Evolution of Digital Mental Health Technologies

The evolution of digital mental health technologies marks a shift from traditional to innovative, data-driven approaches, significantly influenced by AI and immersive digital environments [2]. This shift aligns with the 4th Industrial Revolution, accelerating digital innovation adoption in mental health care [13]. Initial digital mental health interventions (DMHIs) focused on experimental methodologies to enhance user engagement and therapeutic outcomes [30]. These efforts led to a systematic approach characterized by efficacy trials, user-centered design, and strategic implementation [4].

AI-driven research has enabled personalized and precise mental health disorder assessments [24]. Frameworks utilizing LLMs to simulate participant responses exemplify innovative AI applications [31]. The historical development of LLMs supports digital mental health progress, providing robust tools for emotion recognition and assessments [20].

The COVID-19 pandemic underscored the necessity and effectiveness of digital mental health services during global crises [5]. Programs focusing on psychoeducation and behavioral activation highlight technology-supported self-help methods' potential in treating mental health conditions [1]. The evolution of DMHIs has been driven by the need to engage young people reluctant to seek professional help, leading to tailored digital solutions [13].

Integrating blockchain and federated learning in decentralized systems marks a significant milestone, enhancing data security and privacy [2]. The success of foundation models in healthcare further illustrates digital technologies' adaptability and potential to transform mental health care delivery [4]. As digital mental health technologies advance, they present challenges and opportunities for clinical practice, necessitating ongoing adaptation to maximize impact [1].

2.3 Role of Digital Mental Health in Addressing Disparities

Digital mental health technologies promise to reduce disparities in mental health care by enhancing access and personalizing interventions for underserved populations [32]. These technologies use digital phenotyping and continuous monitoring to facilitate proactive health management and early detection, particularly among vulnerable groups such as university students and rural youth. By enabling daily mood tracking and personalized interventions, DMHIs effectively engage individuals, addressing disparities [30].

Culturally sensitive interventions tailored for specific demographics bridge gaps in access, adapting to varying resource availabilities and cultural contexts [27]. Technology-based interventions improve service accessibility for underserved populations, addressing systemic barriers contributing to disparities [22]. Personalization strategies within DMHIs enhance treatment efficacy by tailoring interventions to individual needs, increasing positive outcomes likelihood [33].

Challenges persist in validating digital tools, training clinicians and patients, and implementing organizational changes for successful integration [11]. Deploying LLMs in digital mental health requires substantial medical data, high computational resources, and comprehensive evaluation criteria beyond accuracy [34]. Addressing these challenges is vital to maximizing digital mental health technologies' potential in reducing disparities and improving outcomes [4].

Variability in patient demographics, intervention design, and systemic barriers can hinder consistent engagement with DMHIs, necessitating tailored solutions to enhance accessibility and effectiveness. The intersection of housing instability and sociodemographic factors significantly influences mental

health issues prevalence among youth, impacting treatment access [8]. Addressing these multifaceted challenges, digital mental health technologies can promote equitable mental health care.

3 Artificial Intelligence in Digital Mental Health

The convergence of artificial intelligence (AI) and digital mental health signifies a profound shift in mental health interventions, underscoring AI’s transformative potential. This section explores AI’s foundational role in mental health care, focusing on personalized insights and predictive analytics, which tailor interventions to individual needs, thus broadening the scope and impact of these innovations. Table 3 provides a comparative analysis of various AI methodologies in digital mental health, highlighting their personalization approaches, data utilization strategies, and ethical challenges.

Figure 2 illustrates the hierarchical structure of AI’s integration in digital mental health, showcasing key categories such as AI’s role in mental health care, AI-enabled chatbots, and innovative AI applications. This figure highlights personalized insights, benefits and challenges, empathetic interactions, transformative technologies, and ethical considerations, further elucidating the multifaceted impact of AI on mental health interventions.

3.1 Personalized Insights and Predictive Analytics

AI significantly advances personalized mental health interventions by providing tailored insights and predictive analytics. By integrating AI into mental health care, interventions become responsive to the dynamic, individualized nature of users’ needs [35]. Utilizing domain-specific datasets and actor-critic prompting protocols, AI frameworks enhance the reliability of large language model (LLM) responses, improving mental health assessment precision [25]. These advancements facilitate personalized treatment plans that address specific patient conditions [3].

AI’s ability to process complex relational data through graph representation learning extracts personalized insights, enhancing patient-specific condition understanding and intervention strategies [36]. Multi-agent systems like MentalAgora leverage context-sensitive responses to improve interaction quality in digital mental health support, showcasing AI’s adaptability to individual needs [3]. Wearable technologies, such as Fitbot, exemplify AI’s capacity to recognize emotions through continuous data collection, providing real-time personalized feedback [37].

AI-driven methods for classifying social media data, including tweets from users identifying with autism spectrum disorder (ASD), offer early diagnostic insights, enhancing intervention personalization [38]. These insights, inspired by cognitive psychology, inform AI’s approach to mental health care [31].

Despite AI’s advantages in personalizing mental health care, challenges such as limited access to large-scale medical datasets and privacy concerns persist [29]. Ethical deployment must balance technological capabilities with human-centric considerations to maximize benefits while minimizing potential harms. The effectiveness of digital mental health interventions (DMHIs) relies on human interaction and supervision, enhancing user engagement [39]. Thus, integrating AI technologies requires careful consideration of ethical, privacy, and human factors for successful implementation [6].

3.2 Benefits and Challenges of AI in Mental Health Interventions

Benchmark	Size	Domain	Task Format	Metric
MA[3]	97	Mental Health	Response Generation	BLEU, R-L

Table 1: This table presents a representative benchmark used in evaluating AI systems for mental health interventions, specifically focusing on response generation tasks. The benchmark includes details on the dataset size, domain, task format, and evaluation metrics, providing a comprehensive overview of its application in mental health care.

AI revolutionizes mental health care by enhancing data processing and delivering personalized interventions. AI systems, particularly for autism spectrum disorder (ASD) detection, demonstrate high accuracy, offering reliable diagnostic support [38]. These systems utilize large datasets and

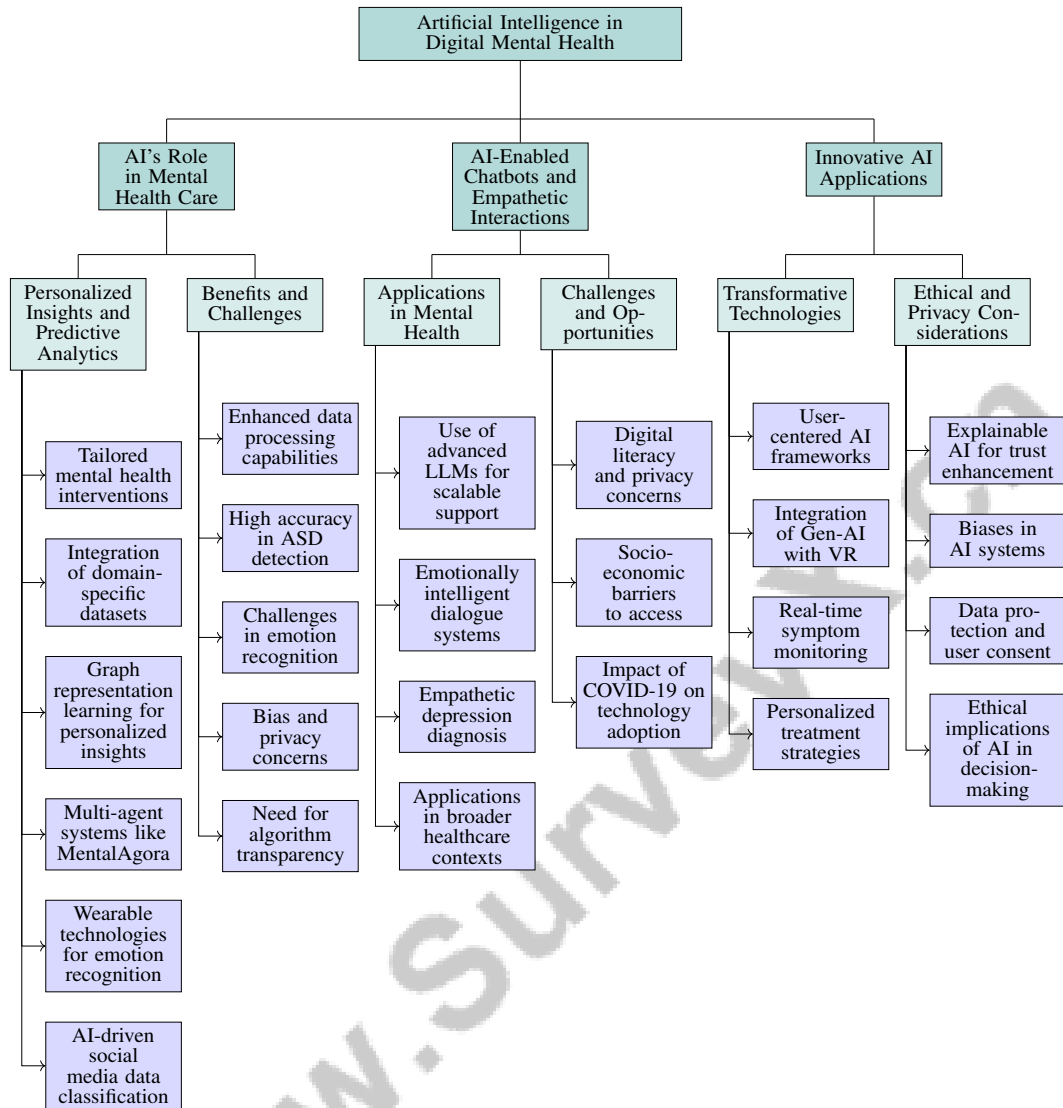


Figure 2: This figure illustrates the hierarchical structure of AI's integration in digital mental health, showcasing key categories such as AI's role in mental health care, AI-enabled chatbots, and innovative AI applications. It highlights personalized insights, benefits and challenges, empathetic interactions, transformative technologies, and ethical considerations.

advanced algorithms for precise mental health assessments, facilitating early intervention [36]. AI's integration of graph representation learning enhances predictive modeling, extracting meaningful insights from electronic health records (EHRs) [36]. Table 1 illustrates a key benchmark employed in the assessment of AI-driven mental health interventions, highlighting its relevance and applicability in the domain.

However, AI deployment in mental health care faces significant challenges. Accurate emotion recognition and personalized interaction are limited, affecting the effectiveness of social and affective robots [37]. Potential biases in AI datasets necessitate rigorous validation and bias mitigation strategies [38]. Data sharing across institutions is crucial for algorithm development but is often hindered by privacy concerns and data standardization needs [40]. Ensuring algorithm transparency and patient safety is essential to foster trust in AI technologies [40]. Challenges such as insufficient data quality, low patient compliance, and sustaining long-term treatment effects further complicate AI integration in mental health interventions [35].

3.3 AI-Enabled Chatbots and Empathetic Interactions

AI-enabled chatbots are pivotal in facilitating empathetic interactions within digital mental health care, using advanced large language models (LLMs) like GPT-4, Mistral Large, and LLama V3.1 to deliver scalable, personalized support [41]. These chatbots recognize and respond to emotional cues, enhancing user engagement through emotionally intelligent dialogue systems [42]. The integration of emotional intelligence in dialogue generation models enables chatbots to provide nuanced, contextually appropriate responses.

In mental health, chatbots are used for reliable, empathetic depression diagnosis, addressing limitations of traditional dialogue frameworks [43]. By incorporating multiple optimization criteria, chatbots navigate human emotion complexities, offering accurate, empathetic support.

Beyond mental health, AI chatbots are applied in broader healthcare contexts, including patient care, medical training, and clinical decision-making [18]. In situations with limited direct access to help, such as supporting domestic abuse victims, chatbots provide discreet, accessible support [44].

The development of AI chatbots with emotionally intelligent capabilities underscores empathy's importance in digital interactions, highlighting their role in creating supportive, engaging user experiences. These technologies improve mental health care accessibility and effectiveness, especially for underserved and remote communities. Digital mental health interventions, including mobile applications and web-based platforms, help bridge care gaps for marginalized populations, such as ethnic minorities and rural individuals. Despite promising developments, challenges like digital literacy, privacy concerns, and socio-economic barriers must be addressed to ensure equitable access. The COVID-19 pandemic has accelerated technology adoption, highlighting its potential to deliver quality mental health services when traditional methods are insufficient. Continued research and tailored approaches are essential to maximize these innovations' impact in diverse communities [10, 28, 7, 22].

3.4 Innovative AI Applications in Mental Health

Method Name	Technological Integration	Personalization and Customization	Targeted Interventions
ASVR[13]	Gen-AI Personalization	Personalized Storytelling	Personalized Interactions
FB[37]	Eeg Data Acquisition	Personalized Interaction	Targeted Interventions
ABC[45]	Machine Learning Models	Individual User Preferences	Real-time Monitoring
SEO[43]	-	-	Real-time Monitoring

Table 2: Overview of AI-Driven Methods for Personalization and Targeted Interventions in Mental Health Care. This table categorizes various AI methodologies based on their technological integration, personalization capabilities, and application in targeted interventions, highlighting the diverse approaches to enhancing mental health treatment through advanced AI technologies.

Innovative AI applications in mental health care transform traditional therapeutic methodologies by integrating cutting-edge technologies that enhance personalization and user engagement. User-centered AI frameworks, as highlighted by Esposito et al., categorize existing end-user development (EUD) methods based on user expertise, customization levels, and application domains, emphasizing tailoring AI tools to diverse user needs [46]. This approach fosters greater accessibility and usability of AI-driven mental health interventions.

Integrating generative AI (Gen-AI) personalization with virtual reality (VR) facilitates dynamic storytelling, allowing users to interact with characters and influence narratives, enhancing engagement and therapeutic outcomes [13]. This integration creates immersive therapeutic experiences that adapt to individual preferences and emotional states, offering a more interactive approach to mental health care.

The innovation of Fitbot exemplifies AI's potential to provide emotionally aware user experiences by integrating multiple technologies, such as EEG data acquisition and advanced algorithms [37]. Fitbot processes real-time physiological data and delivers personalized feedback, enhancing emotional regulation and supporting mental health interventions.

AI applications in mental health are making strides in real-time symptom monitoring and personalized treatment strategies, particularly for conditions like schizophrenia [35]. These advancements improve rehabilitation experiences by offering timely, customized interventions that address individual needs.

Collectively, these innovative AI applications highlight AI technologies’ transformative potential in mental health care, offering new avenues for personalized, engaging, and effective therapeutic interventions. As technology advances, it holds the potential to transform mental health service delivery and accessibility, especially for underserved populations. Digital mental health interventions are promising in addressing disparities faced by marginalized groups, including racial and ethnic minorities, rural communities, and individuals experiencing homelessness. These interventions overcome traditional care barriers, providing accessible, low-cost resources adaptable to diverse needs. While initial findings suggest these technologies improve mental health outcomes, further research is necessary to establish their real-world effectiveness and ensure ethical, equitable implementation. The ongoing evolution of these technologies could significantly enhance mental health care quality for those who need it most, provided developers and practitioners collaborate closely with stakeholders to tailor solutions to these populations’ unique challenges [10, 28, 7, 22].

Table 2 provides a comprehensive categorization of AI methodologies employed in mental health care, focusing on their technological integration, personalization, and targeted intervention capabilities.

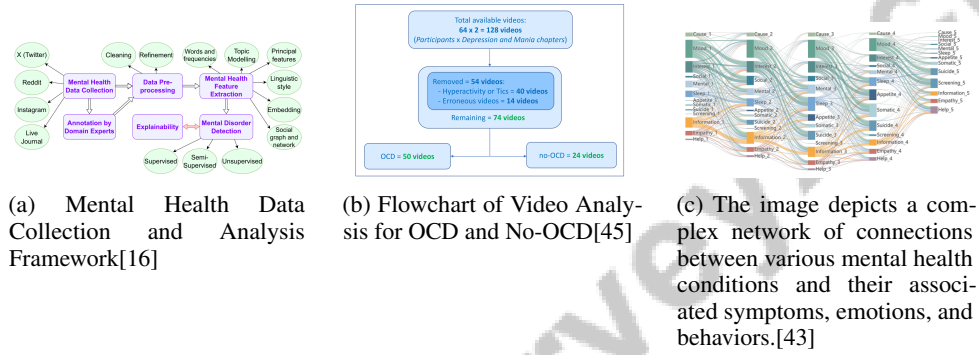


Figure 3: Examples of Innovative AI Applications in Mental Health

Figure 3 illustrates AI’s innovative applications in digital mental health, showcasing transformative approaches in understanding, diagnosing, and treating mental health conditions. The first approach involves a comprehensive data collection and analysis framework using social media platforms like Twitter, Reddit, Instagram, and Live Journal to gather data. This framework processes, extracts features, and detects mental disorders using advanced methods. The second approach details video analysis for distinguishing Obsessive-Compulsive Disorder (OCD) from non-OCD cases, enhancing OCD diagnosis accuracy. Lastly, the third approach presents a complex network visualization of mental health conditions, depicting connections between conditions, symptoms, emotions, and behaviors. These examples highlight AI’s innovative role in enhancing digital mental health, providing new tools and insights for clinicians and researchers [16, 45, 43].

3.5 Ethical and Privacy Considerations

Integrating AI into mental health care requires careful ethical and privacy considerations to ensure responsible deployment. A primary ethical issue is the opacity of advanced AI models, often perceived as "black-box" systems, undermining trust in AI-generated mental health assessments. Explainable AI is critical to enhance understanding and trust among clinicians and patients, enabling comprehension of AI-driven insights [47].

Biases in AI systems present another ethical challenge, potentially perpetuating disparities and resulting in unfair treatment of certain populations. Addressing these biases requires incorporating fairness considerations into AI applications, promoting equitable mental health outcomes. The integration of AI with neuroimaging data raises significant privacy concerns, particularly in decoding brain signals [48]. Ensuring data protection and user consent is paramount in safeguarding sensitive personal information.

AI’s role in augmenting clinical decision-making introduces additional ethical considerations. AI applications in mental health can serve as triage tools, replacements for specific tasks, or augmentations of human providers, each with distinct ethical implications [40]. The integration of artificial

emotions into AI has been proposed to enhance its exploratory behavior and overall learning, raising questions about the ethical ramifications of AI systems mimicking human emotional states [31].

Moreover, AI deployment in mental health care is limited by the need for high-quality data and challenges in user engagement with digital tools. Integrating AI solutions with traditional rehabilitation methods must be approached with caution to ensure technological advancements do not compromise care quality [35].

Feature	Personalized Insights and Predictive Analytics	Benefits and Challenges of AI in Mental Health Interventions	AI-Enabled Chatbots and Empathetic Interactions
Personalization Approach	Tailored Insights	Reliable Diagnostics	Emotionally Intelligent
Data Utilization	Domain-specific Datasets	Large Datasets	Emotional Cues
Ethical Considerations	Privacy Concerns	Bias Mitigation	Socio-economic Barriers

Table 3: Comparison of AI methodologies in digital mental health, focusing on personalization, data utilization, and ethical considerations. This table delineates the approaches and challenges associated with personalized insights, predictive analytics, AI-enabled chatbots, and the ethical implications of AI in mental health interventions.

4 Virtual Reality for Immersive Therapeutic Experiences

The utilization of Virtual Reality (VR) in therapeutic settings emphasizes designing immersive environments that enhance interpersonal skills by simulating real-world interactions. These environments provide safe spaces for users to practice and refine social competencies, underscoring VR's therapeutic potential.

4.1 Immersive Environments and Interpersonal Skills

VR technologies revolutionize therapy by creating immersive settings that bolster interpersonal skills. Users engage with avatars in realistic simulations, enhancing social competencies in controlled environments [14]. These simulations expose individuals to diverse social scenarios, fostering essential communication and relationship-building skills.

Frameworks using metaphoric representations, like the 3D city metaphor, organize information related to Virtual, Augmented, and Mixed Reality technologies, enhancing user engagement and facilitating the learning of interpersonal skills [15]. VR environments also allow users to influence narratives and reflect on cultural values, deepening their understanding of social dynamics [13]. This active participation fosters agency, enabling users to tailor experiences to therapeutic goals, thus enhancing efficacy.

Intelligent systems within VR platforms, such as Social DAO, provide real-time support and collaboration, improving interpersonal skills and mental health outcomes [49]. These advanced applications create more engaging therapeutic processes tailored to diverse individual needs.

4.2 Virtual Reality Technologies and User Interaction

VR technologies leverage deep learning and natural language processing (NLP) to enhance user interaction through emotionally aware responses [42]. These technologies foster immersive environments that mimic real-world experiences, increasing therapeutic interventions' realism and effectiveness. Emotionally intelligent dialogue systems within VR platforms facilitate dynamic interactions, enabling real-time responses to emotional cues.

Advanced VR technologies provide immersive simulations of complex social situations, promoting experiential learning that improves interpersonal skills. This approach is particularly beneficial for individuals with initial deficits in these areas. By integrating AI and avatar interactions, VR frameworks offer valuable feedback on user performance, supporting development [12, 13, 14, 15]. In mental health care, VR serves as a controlled environment for exposure therapy and cognitive behavioral interventions, reducing anxiety and improving social functioning.

Deep learning algorithms in VR systems personalize user experiences by analyzing interactions and adjusting environments to meet therapeutic needs. This adaptability maintains engagement and ensures therapy customization, as seen in frameworks like MentalAgora [3, 33]. Evolving VR technologies promise to transform mental health care by providing innovative therapeutic tools.

4.3 Impact of COVID-19 on VR Adoption

The COVID-19 pandemic accelerated VR integration into mental health care, highlighting digital interventions' importance during social distancing. This shift emphasized VR's role in enhancing access to psychological treatments amid stigma and geographical barriers, revealing gaps in mental health services and underscoring workforce training needs [5, 11, 22]. As face-to-face therapy became challenging, VR emerged as a viable alternative, offering immersive environments for mental health interventions.

VR's increased adoption is attributed to its ability to simulate real-world environments, facilitating therapeutic activities challenging to replicate digitally. VR platforms have proven innovative tools in mental health treatment, enabling exposure therapy and cognitive behavioral therapy (CBT). These immersive environments enhance presence and interaction, crucial for effective outcomes. By leveraging VR, clinicians deliver evidence-based interventions more engagingly, addressing accessibility and personalization barriers [4, 5, 41, 22]. This capability became valuable as professionals sought innovative care delivery methods during isolation.

Rapid VR integration revealed limitations like user discomfort with movement techniques and visual overload, necessitating refinement to enhance user experience [15]. Despite challenges, the pandemic underscored VR's role in expanding mental health care access, prompting continued investment and research into optimizing VR technologies for therapeutic purposes. As VR adoption grows, it holds potential to transform mental health care by providing accessible, engaging, and effective treatment options.

4.4 Cybersickness and Explainable AI in VR

Cybersickness poses a challenge in VR environments, often causing discomfort or disorientation. Traditional detection methods are computationally intensive and lack explainability, making them unsuitable for energy-constrained VR headsets [50]. The LiteVR framework addresses these challenges by incorporating explainable AI techniques to enhance cybersickness detection and understanding.

LiteVR uses Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), and Multi-Layer Perceptron (MLP) models, integrated with SHAP-based feature explanations, optimizing performance and interpretability [50]. This integration identifies influential features contributing to cybersickness, reducing model complexity and computational demands. LiteVR achieves a classification accuracy of 94

Explainable AI's application in LiteVR is crucial for deployment in sensitive domains like healthcare, where advanced AI models' opacity poses challenges [47]. By providing transparent insights into cybersickness factors, LiteVR improves user experience and supports equitable application in VR-based therapeutic interventions. As VR technologies evolve, integrating explainable AI methods, as demonstrated by LiteVR, is essential for addressing cybersickness complexities and enhancing efficacy in mental health care applications.

4.5 Immersive Storytelling in Therapy

Immersive storytelling in VR therapy represents a transformative approach to mental health treatment, leveraging narrative-driven experiences to improve outcomes. This method utilizes VR's capabilities to create engaging environments for users to explore personal narratives and emotional landscapes in controlled settings. By integrating storytelling elements, VR therapy enables reflection on personal stories, fostering deeper understanding of challenges and emotional responses [13].

Immersive storytelling effectively addresses complex psychological issues, providing a safe space for users to experiment with perspectives and solutions. This approach encourages active participation, allowing influence over narratives and exploration of outcomes, fostering agency and empowerment. The immersive nature of storytelling, particularly through VR and generative AI (Gen-AI), enhances coping strategies and problem-solving skills, revitalizing cultural traditions and personal reflection, leading to significant mental health improvements [13, 3, 33, 14].

Integrating generative AI with VR storytelling enhances personalization, allowing adaptive narratives that respond to emotional states and therapeutic needs [13]. This customization ensures therapy sessions are tailored to individual requirements, promoting engagement and facilitating progress.

As VR technologies advance, they increasingly support immersive storytelling techniques that enhance therapeutic practices, particularly in mental health treatment. By incorporating generative AI for narrative personalization, VR creates engaging experiences that empower users in their healing processes. This innovative approach revitalizes traditional storytelling methods, encouraging cultural learning and personal engagement, offering new avenues for effective interventions [12, 13, 16, 15]. By providing immersive platforms for self-exploration and healing, VR storytelling holds potential to revolutionize therapeutic practices and improve accessibility to mental health care.

5 Teletherapy: Remote Counseling via Digital Platforms

5.1 The Rise of Teletherapy

Teletherapy has emerged as a pivotal development in mental health care, driven by the need for accessible and flexible therapeutic solutions. Utilizing digital platforms, it effectively overcomes traditional obstacles like stigma, geographic constraints, and time limitations. The COVID-19 pandemic significantly boosted teletherapy adoption, underscoring the importance of remote interventions. Digital mental health technologies, including internet-based interventions and mobile apps, have proven to enhance treatment accessibility and efficacy, particularly in low- and middle-income countries where traditional resources are limited [10, 20, 5, 22]. This evolution has normalized teletherapy, fostering broader acceptance across diverse populations.

Advancements in communication technologies and the growing acceptance of remote counseling as a viable alternative to in-person sessions have fueled teletherapy's rise. It offers a convenient, private means of accessing mental health care, especially for those facing geographical, physical, or emotional barriers. Anonymity is a critical feature, particularly for individuals dealing with sensitive issues like domestic abuse, where stigma may deter them from seeking help [44].

Despite its benefits, teletherapy requires ongoing evaluation of efficacy and workforce training to ensure equitable access. The integration of advanced technologies, such as AI-enabled chatbots and virtual reality, presents opportunities to enhance therapeutic experiences but also necessitates careful consideration of privacy and security concerns [11, 22, 5, 10, 19]. Addressing these challenges is crucial for expanding the reach and effectiveness of mental health services in the digital era.

5.2 Advantages and Challenges of Teletherapy

Teletherapy offers significant advantages in mental health care by increasing accessibility and flexibility. Clients can attend therapy sessions from home, overcoming geographical barriers and reducing travel-related costs, which is particularly beneficial in low- and middle-income countries with limited mental health services. Studies show that digital mental health interventions enhance treatment feasibility and participant satisfaction, transforming care delivery and addressing disparities [10, 20]. The anonymity of teletherapy encourages those hesitant to seek in-person therapy due to stigma or privacy concerns.

However, teletherapy also presents challenges, such as the potential reduction in human interaction, which may impact the therapeutic alliance—a critical component of successful interventions [12]. Platforms must also navigate ethical concerns and data security risks to maintain client confidentiality [12].

The integration of technologies like AI and virtual reality offers opportunities for personalized interventions, yet raises ethical issues, including algorithmic bias and transparency in AI-driven decision-making [12]. Mental health professionals must adeptly manage these challenges while leveraging digital platforms to enhance service effectiveness.

5.3 Digital Therapeutic Alliance

The digital therapeutic alliance is crucial for effective mental health interventions, especially in AI-driven therapies. Establishing a strong alliance in digital settings fosters trust, engagement, and adherence to treatment protocols [16], underpinning successful outcomes despite the absence of face-to-face interactions.

A primary challenge is the limited research on the nuances of the digital therapeutic alliance, complicating intervention quality assessment [21]. Addressing this gap requires comprehensive studies on cultivating and sustaining digital therapeutic relationships.

Advancements in AI promise to enhance the digital therapeutic alliance. AI-enabled chatbots designed for empathetic depression diagnosis show significant improvements in patient engagement and therapeutic interactions [43]. These systems provide personalized, empathetic responses, strengthening the alliance and improving digital intervention efficacy.

As digital mental health evolves, prioritizing strategies to enhance the therapeutic alliance is essential. Addressing engagement challenges—such as individual characteristics, intervention design, and systemic barriers—can optimize outcomes, particularly for marginalized populations facing access barriers. Integrating culturally sensitive designs and innovative engagement strategies ensures digital interventions resonate with diverse individuals, fostering greater accessibility and equity in mental health support [7, 23, 11].

5.4 Privacy and Security Concerns

Privacy and security are critical in teletherapy, where protecting client information is essential for trust and ethical practice. A major challenge is the lack of transparency in data collection, leading to user manipulation and inadequate protection under regulations like GDPR [17]. The complexity of digital interactions and the vast data generated during teletherapy necessitate robust security measures to safeguard privacy.

AI integration in teletherapy complicates privacy concerns, as systems often require extensive datasets. This reliance on data raises ethical issues regarding user consent and potential misuse of personal information. Many users are unaware of data collection and sharing practices, leading to privacy violations and eroding trust. Establishing a consent-forward paradigm prioritizing affirmative consent is essential for empowering users to make informed choices about their data [24, 51, 17, 1]. Ensuring users are informed about data practices and have control over their information is critical to addressing these concerns.

To maintain confidentiality in teletherapy, secure communication protocols and advanced encryption technologies must be implemented to protect sensitive information from unauthorized access [20, 17, 18, 19, 1]. These measures prevent unauthorized access and data breaches, enhancing the overall security of digital mental health services. As teletherapy expands, continuous efforts to improve privacy and security frameworks are crucial for fostering trust and ensuring safe mental health care delivery in digital settings.

6 Digital Therapeutics: Evidence-Based Interventions

6.1 Efficacy of Digital Therapeutics

Digital therapeutics are increasingly central to mental health care, providing scalable, evidence-based interventions that enhance treatment access and adherence through digital platforms [5]. The integration of machine learning models facilitates precise, automated patient behavior analysis, surpassing human observation limitations and enabling personalized interventions [45]. Mobile applications significantly boost patient engagement and adherence, improving therapeutic outcomes [21]. For instance, the Step-by-Step intervention effectively targets depression by combining psychological theory with user-centered design [27]. Additionally, deep-learning models for stress prediction using GPS data exemplify the timely support digital therapeutics can offer [52].

AI-enabled chatbots, utilizing frameworks like SEO, enhance dialogues for depression diagnosis, improving task completion and emotional support [43]. These systems demonstrate digital therapeutics' capability to provide empathetic mental health assistance while addressing bias and privacy through human oversight and federated learning [41]. Platforms like MentalAgora further illustrate digital therapeutics' relevance by generating expert-aligned responses in real-world contexts [3].

Despite these advancements, real-world evaluations remain crucial, emphasizing user-centered designs to meet diverse patient needs [10]. Personalized approaches, such as the ACQ's method for profiling personality self-reports, highlight the importance of tailoring interventions to individual

characteristics for optimal outcomes [53]. As digital therapeutics evolve, their potential to transform mental health care through innovative, personalized, and scalable interventions remains substantial.

6.2 Implementation Strategies and Challenges

Implementing digital mental health interventions (DHMIs) involves navigating organizational, sociopolitical, and economic barriers. Reimbursement issues often hinder the widespread adoption and sustainability of digital therapeutic services [30]. Without clear frameworks, providers may hesitate to integrate digital therapeutics, limiting accessibility and impact. Additionally, many healthcare professionals lack familiarity with digital mental health technologies, which can impede their integration into clinical workflows [4]. Comprehensive training programs are essential to equip providers with the necessary skills.

Privacy concerns also present challenges, as the collection and use of sensitive data are fundamental to digital therapeutics. Robust data protection measures and transparent privacy policies are crucial for building user trust and facilitating technology adoption [4]. Integrating digital therapeutics into existing healthcare systems requires careful consideration of how these interventions complement traditional mental health services rather than disrupt them.

Strategic implementation efforts should foster collaboration among technology developers, healthcare providers, and policymakers. This collaboration can lead to standardized guidelines and best practices for deploying digital therapeutics, ensuring alignment with clinical goals and regulatory requirements. By addressing the complexities of integrating digital therapeutics, these solutions can provide scalable, personalized interventions that enhance patient outcomes, engagement, and retention in real-world settings. This integration necessitates clinician training, co-designing accessible tools, and establishing standardized guidelines for measuring effectiveness and potential risks [21, 11, 30].

6.3 Integration into Traditional Mental Health Care

Integrating digital therapeutics into traditional mental health care enhances service delivery and effectiveness by providing scalable, personalized interventions that complement conventional approaches [5]. Digital platforms enable practitioners to extend their reach, offering support to individuals facing barriers to traditional therapy [45]. This integration allows for continuous monitoring and real-time feedback, enhancing the therapeutic process and enabling more responsive interventions [52]. Digital tools can track patient progress, identify issues early, and adjust treatment plans as needed [3].

However, successful integration requires addressing interoperability challenges between digital platforms and existing healthcare systems. Establishing standardized protocols and ensuring compatibility with electronic health records (EHRs) is essential for streamlining the incorporation of digital therapeutics into traditional care settings [4]. Training healthcare professionals to effectively utilize digital tools is crucial for maximizing their potential and ensuring they complement rather than replace traditional methods [30]. Ethical considerations, particularly regarding data privacy and patient consent, must also be addressed [4]. Implementing robust data protection measures and ensuring transparency in data usage are vital for maintaining patient trust and safeguarding sensitive information.

6.4 Cultural Sensitivity and Tailoring Interventions

Implementing digital therapeutics in mental health care requires a focus on cultural sensitivity and personalization to address diverse patient needs effectively. Cultural sensitivity ensures interventions are relevant and respectful of various populations' cultural contexts and values, enhancing engagement and therapeutic outcomes [8]. This approach is crucial for children facing housing instability, as digital interventions can offer tailored services that meet their unique circumstances.

Developing culturally sensitive digital therapeutics involves understanding the specific cultural, social, and economic factors influencing mental health and treatment preferences. Tailoring interventions to accommodate these factors can strengthen the therapeutic relationship and enhance the digital therapeutic alliance, a critical component of effective mental health care [21]. Despite potential benefits, gaps remain in understanding how digital tools impact the therapeutic relationship and what constitutes a strong digital therapeutic alliance. Addressing these gaps requires ongoing research and

developing guidelines to ensure digital therapeutics are culturally appropriate and personalized for diverse populations.

By prioritizing cultural sensitivity and tailoring interventions, digital therapeutics can improve mental health services' accessibility and effectiveness, especially for underserved and marginalized communities. This strategy enhances patient engagement and satisfaction by leveraging digital mental health interventions (DMHIs), which effectively address mental health disparities among marginalized populations. Integrating supportive features such as gamification and human interaction, while addressing systemic barriers to care, promotes equitable access to mental health services and fosters improved health outcomes for all individuals, ultimately contributing to a more inclusive and effective mental health care delivery system [20, 7, 23, 21].

7 Mental Health Apps: Self-Guided Management and Support

7.1 Accessibility and User Engagement

Mental health apps have emerged as pivotal tools in digital mental health, offering flexible platforms for self-guided management and support. They effectively mitigate barriers such as geographical limitations and the stigma associated with seeking help, thereby enhancing accessibility for underserved and rural populations [28]. The ubiquity of mobile devices further amplifies their reach.

To enhance engagement, these apps incorporate personalized, interactive features tailored to individual preferences, leveraging data-driven insights and user feedback to create resonant experiences that motivate regular use [28]. Gamification elements, including rewards and progress tracking, further enrich user interaction by making the experience more enjoyable.

Mobile sensing technologies significantly contribute to user engagement by delivering real-time feedback and personalized recommendations based on behavioral data, ensuring timely support tailored to users' mental health needs [28]. Social features such as peer support and community forums foster a sense of belonging, encouraging active participation in users' mental health journeys.

Challenges in user retention and sustained engagement remain, influenced by factors like individual characteristics, symptom severity, and design elements such as human support and gamification. Organizational and social barriers complicate technology implementation, underscoring the need for comprehensive strategies to enhance user interaction and long-term adherence [10, 21, 23]. Ongoing research and innovation are vital to identify effective strategies for maintaining user interest and adherence, ultimately expanding mental health apps' reach and impact for individuals managing their mental health independently.

7.2 Mobile Sensing and Predictive Analytics

The integration of mobile sensing technologies and predictive analytics in mental health apps represents a significant leap forward, providing innovative solutions for real-time monitoring and intervention. Technologies like GPS data are employed to predict stress levels, highlighting their potential for timely, personalized mental health support [52]. By continuously collecting and analyzing behavioral and environmental data, these apps can identify patterns and triggers associated with mental health conditions.

Predictive analytics enhances the ability to forecast potential mental health crises and deliver proactive interventions. Using mobile sensing data from smartphones and wearables, these applications generate personalized insights tailored to each user's needs. This process, known as digital phenotyping, employs advanced techniques like large language models (LLMs) to analyze behavioral patterns and predict outcomes, improving personalized health management strategies. The integration of IoT technologies enables continuous monitoring of metrics such as sleep and activity levels, supporting tailored interventions [54, 55]. This personalization enhances assessment accuracy and increases engagement through relevant feedback.

Mobile sensing and predictive analytics also facilitate adaptive interventions that respond to changes in mental health status in real time, ensuring timely, relevant support tailored to users' needs, significantly improving digital interventions' effectiveness and engagement, especially for those at risk for or diagnosed with serious mental illnesses [20, 21, 39].

Addressing data privacy and user consent challenges is crucial for ethical deployment. Users must have control over their data and be informed about its collection, sharing, and utilization, aligning with the consent-forward paradigm that emphasizes affirmative consent in digital mental health tools' design [16, 11, 1]. As the field evolves, ensuring transparency and ethical considerations in data use is critical, particularly as digital platforms enhance mental health analytics and care delivery.

7.3 Ethical and Regulatory Considerations

Developing and deploying mental health apps necessitates careful examination of ethical and regulatory considerations to protect user privacy and ensure intervention integrity. A primary ethical concern is data collection practices' opacity, which can lead to user manipulation and insufficient protection under regulations like GDPR [17]. Transparency in data collection, storage, and utilization is crucial for maintaining user trust and regulatory compliance.

The integration of advanced technologies such as AI introduces additional ethical challenges, particularly regarding algorithmic biases and the need for transparency in AI-driven decision-making processes [12]. Addressing these biases requires implementing fairness considerations in AI models to promote equitable outcomes across diverse populations.

Regulatory frameworks must adapt to the rapid advancements in digital health technologies, particularly concerning mental health applications. This evolution is essential to ensure apps comply with standards protecting user rights while promoting safe, evidence-based interventions. As reliance on digital mental health solutions increases, regulations must address critical issues, including user consent, data privacy, and the necessity for personalized, culturally relevant care. Furthermore, as digital tools become integrated into clinical practice, regulatory measures must facilitate safe implementation while fostering user engagement and trust [21, 5, 11, 1]. This includes establishing guidelines for ethical AI and mobile sensing technologies use and ensuring users provide informed consent for data collection and use.

Implementing mental health apps in sensitive areas, particularly involving minors or individuals with severe mental health conditions, necessitates rigorous evaluation and oversight to protect vulnerable populations. This is critical given the unique challenges these groups face, such as privacy concerns, informed consent issues, and the need for culturally sensitive approaches. Comprehensive assessments of existing digital interventions can guide the development of effective and safe mental health resources tailored to specific needs, enhancing accessibility and efficacy while safeguarding well-being [28, 20, 7, 21]. By prioritizing ethical and regulatory considerations, developers and stakeholders can foster a digital mental health ecosystem that is both innovative and responsible, enhancing mental health care's accessibility and efficacy.

8 Challenges and Future Directions

The domain of digital mental health interventions (DHMIs) is confronted with numerous challenges that impede their efficacy and accessibility. This section addresses the technological and methodological hurdles in DHMIs' integration and implementation, setting the stage for innovative solutions.

8.1 Technological and Methodological Challenges

DHMIs encounter significant technological and methodological challenges affecting their effectiveness and adoption. Key issues include low completion rates and privacy concerns, which reduce usability across diverse populations [4]. Additionally, reliance on specific attributes that fail to capture the full range of user needs limits the effectiveness of digital mental health benchmarks like MentalAgora [3].

Technologically, biased data sources, especially from social media, compromise the accuracy of diagnostic models for conditions such as autism spectrum disorder (ASD) [38]. The need for hyperparameter optimization and extensive training data to improve AI model performance remains a significant barrier [48]. Moreover, individual variability in stress responses and noise in self-reported data complicate the development of reliable digital mental health solutions [52].

Methodologically, inconsistent engagement reporting metrics and systemic barriers to DHMI adoption pose substantial challenges [23]. High dropout rates and insufficient personalization necessitate robust user engagement strategies [5]. Additionally, small sample sizes and a lack of rigorous evaluation frameworks limit the generalizability and effectiveness of digital interventions [20].

Technological infrastructure, including wearable devices, faces constraints related to battery life, network connectivity, and privacy issues [37]. These challenges underscore the need for advancements that ensure secure and reliable user experiences.

8.2 Cultural and Socioeconomic Barriers

Cultural and socioeconomic barriers significantly impact the adoption and effectiveness of digital mental health technologies. These barriers include restrictive cultural beliefs that stigmatize mental health care, language limitations that hinder communication, and institutional racism that perpetuates disparities in access [20, 7, 5, 10, 19].

Restrictive religious beliefs and the absence of native language options in mental health applications limit accessibility and user engagement, particularly in multicultural societies [28]. The adaptability of interventions, such as the Step-by-Step program, is crucial for overcoming these barriers by accommodating diverse user needs [27].

Socioeconomic factors, including housing instability and the underrepresentation of marginalized groups like BIPOC youth, exacerbate disparities in mental health care access [8]. These issues contribute to treatment non-utilization and underscore the need for targeted strategies addressing the unique challenges faced by underserved communities [8].

The integration of Internet of Things (IoT) technologies in mental health care also grapples with patient engagement and adherence to health protocols, influenced by cultural and socioeconomic contexts [54]. Additionally, biased AI systems can perpetuate existing disparities, highlighting the need for equitable approaches, such as the MAFL-CNN model, to ensure fair treatment across diverse populations [56].

Institutional racism and sociodemographic complexities further complicate the adoption of digital mental health technologies, necessitating a comprehensive understanding of these barriers to develop effective solutions [32]. Current studies often overlook the manipulative practices of AI companions that may lead to privacy violations and user exploitation, underscoring the need for greater transparency and ethical considerations in digital mental health interventions [17].

Addressing these cultural and socioeconomic barriers requires the development of inclusive and culturally sensitive digital mental health solutions that prioritize user needs and promote equitable access. By actively addressing the identified challenges—such as effective training for clinicians and patients, creative organizational changes, and standardized guidelines for evidence synthesis—stakeholders can significantly enhance the effectiveness and accessibility of these interventions, ultimately improving mental health outcomes for individuals across diverse populations [10, 20, 11].

8.3 Future Directions and Innovations

The future of digital mental health technologies is poised for transformative advancements that enhance efficacy, accessibility, and ethical deployment. A key area for development is the integration of culturally appropriate, affordable, and user-friendly interventions aimed at effectively engaging young people [28]. Future research should prioritize the creation of universally applicable digital mental health (DMH) tools, enhance stakeholder involvement in intervention design, and address biases in AI-driven mental health technologies [7]. Additionally, innovations in graph representation learning are essential for improving explainability and robustness in clinical AI applications, thereby enhancing the precision and reliability of mental health assessments [36].

Empirical validation of consent-forward practices and the refinement of user experiences are crucial for enhancing the framework's effectiveness [1]. This includes developing comprehensive governance frameworks for AI, emphasizing participatory decision-making, and exploring AI's role in fostering cooperation and moral reasoning [24]. Moreover, enhancing human interpretability in AI communication channels is vital, especially in sensitive healthcare domains, to ensure that AI-driven insights are accessible and actionable for clinicians and patients [47].

In the context of the metaverse, future research should focus on developing adaptive security frameworks and exploring novel technologies that can inform innovations in digital mental health [2]. Longitudinal studies assessing the impact of immersive technologies, such as virtual reality (VR) and generative AI (Gen-AI), on user engagement are necessary to understand their long-term effects on mental health interventions [13]. Additionally, future research should explore the integration of AI in DMHIs while addressing ethical concerns surrounding digital interventions [5].

To tackle the limitations of non-IID data handling, future research should investigate decentralized AI trends, enhancing the scalability and robustness of federated learning and blockchain integrations [29]. Expanding the attributes utilized in platforms like MentalAgora will better cater to diverse user needs, improving effectiveness in clinical settings [3]. Furthermore, future research should emphasize larger, more rigorous randomized controlled trials across various demographics and contexts, integrating digital interventions into existing health systems [20].

Future inquiries could also delve into the integration of multiple emotional states and their cumulative effects on exploration, as well as the implications for broader AI applications [31]. This includes refining computational models of self-identification to better capture human cognition and emotional processing, indicating potential innovations in digital mental health [6]. Additionally, research should focus on social media analysis, serious games for cognitive training, multimodal data integration, and leveraging large language models for personalized patient support [35].

Focusing on emerging research directions and addressing existing misconceptions will enhance the development and implementation of digital mental health technologies. This approach prioritizes user well-being and ethical standards while overcoming challenges related to clinical integration, data privacy, and the effective use of innovative tools like large language models. These efforts have the potential to significantly reshape the mental health care landscape, making it more accessible, equitable, and responsive to user needs [10, 19, 11, 1].

9 Conclusion

The exploration of digital mental health technologies reveals their transformative potential in revolutionizing mental health care through the integration of advanced tools like AI, VR, and digital therapeutics. These innovations exemplify the scalability and adaptability of digital interventions, although further empirical studies are necessary to comprehensively evaluate their effectiveness. The concept of emotional digital twins emerges as a pivotal advancement, enhancing user engagement and support by fostering personalized digital interactions.

The findings underscore the necessity for ethical, evidence-based, and inclusive implementation of these technologies to ensure their benefits reach diverse populations. AI-equipped systems, such as the Social DAO, illustrate improved coordination and efficacy in addressing mental health challenges, highlighting their applicability in real-world scenarios. Moreover, the synergy of VR immersion and generative AI personalization notably boosts user engagement, indicating a promising avenue for revitalizing cultural learning and traditions.

Additionally, the survey underscores the significance of self-identification within computational frameworks, offering novel perspectives on mental health and AI applications. Agent-based simulation models developed in this context provide valuable insights into the implications of digital mental health solutions, setting the stage for future validation and experimentation.

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