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DIGITAL INTERVENTIONS FOR ADOLESCENT DEPRESSION AND ANXIETY: NARRATIVE REVIEW AND FUTURE DIRECTIONS

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ABSTRACT

Introduction: Adolescence is a critical developmental stage during which individuals are particularly vulnerable to mental health challenges, including depression and anxiety. Despite their high prevalence, access to traditional mental health care remains limited for many adolescents.
Purpose of the study: This narrative review aims to synthesize current evidence regarding the effectiveness of digital interventions—such as mobile applications, internet-based cognitive behavioral therapy (iCBT), conversational AI, gamified tools, and peer-support platforms—in reducing symptoms of depression and anxiety among adolescents.
Materials and methods: A comprehensive literature review was conducted, including 35 peer-reviewed studies and systematic reviews published between 2015 and 2025. Sources were identified using PubMed and Scopus databases, focusing on digital mental health tools targeting individuals aged 10–24 years.
Conclusions: Digital mental health interventions show promising efficacy in addressing adolescent depression and, to a lesser extent, anxiety. Evidence supports their potential for increased accessibility, user engagement, and stigma reduction. However, gaps remain in standardization, cultural adaptation, and long-term evaluation. Further research should address these limitations and guide the integration of digital tools into youth mental health care systems.

KEYWORDS

Adolescent, Depression, Anxiety, Digital Health, Mobile Applications, Cognitive Behavioral Therapy

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1. Introduction

Adolescence is a fundamental developmental stage, during which individuals undergo significant and rapid maturation at the biological, emotional, and social levels [1]. Worldwide, an estimated one in seven (14%) adolescents aged 10–19 experience mental health conditions, yet these issues are largely unrecognized and untreated [2]. According to the World Health Organization, depression ranks among the primary causes of illness and disability in adolescents across the globe [1]. Anxiety disorders represent some of the most frequently diagnosed mental health conditions in adolescents, commonly coexisting with depressive symptoms and profoundly influencing educational outcomes, social relationships, and life satisfaction [3].

Although these conditions are highly prevalent, many adolescents still experience considerable challenges in obtaining traditional mental health care. Perceived stigma related to mental illness can lead adolescents to internalize feelings of shame and embarrassment, which in turn reduces their willingness to seek professional psychological support. [4] Structural and practical factors—such as financial costs, limited awareness of available mental health services, and time constraints—were frequently identified as major barriers preventing young people from seeking help [5]. Digital health interventions (DHIs) have the potential to enhance the accessibility of mental health services for children and adolescents [6].

In the past decade, digital mental health interventions targeting adolescents have experienced significant growth. These interventions encompass a variety of formats, including mobile applications, internet-based cognitive-behavioral therapy (iCBT), chatbot-guided programs, and platforms utilizing gamification or virtual reality (Clarke et al., 2015). Systematic reviews have demonstrated that computerized cognitive-behavioral therapy (cCBT) is effective in reducing symptoms of anxiety and depression among adolescents aged 10–24 years [7]. The appeal of these digital tools to adolescents is attributed to their accessibility, anonymity, and user-friendly interfaces. Studies indicate that such features enhance engagement and adherence among young users, making digital interventions a promising avenue for mental health support in this demographic [8].

This narrative review aims to provide a comprehensive overview of current evidence on the effectiveness of digital interventions in reducing symptoms of depression and anxiety in adolescents, and suggests possible directions for future research and clinical practice.

2. State Of Knowledge

Types of Digital Interventions

Digital mental health tools include a wide range of technology-based approaches aimed at preventing or addressing psychological difficulties. These interventions differ in their delivery methods, degree of user interaction, therapeutic support, and integration with clinical care [6].

- **Mobile applications**

Mobile mental health applications represent a widely accessible format of digital intervention, offering self-guided tools for emotional support, symptom tracking, and stress reduction. These apps commonly incorporate features such as mood diaries, mindfulness exercises, cognitive-behavioral strategies, journaling prompts, and guided breathing techniques [7]. Clarke et al. (2015) highlight that the rapid growth in the use of online technologies among youth provides an opportunity to increase access to evidence-based mental health resources, emphasizing the potential of digital interventions in promoting youth wellbeing and reducing mental health problems [8]. Popular examples include *Sanvello*, which combines mood tracking and CBT-based exercises; *Headspace*, focused on mindfulness and meditation; and *MoodMission*, which recommends evidence-based coping strategies based on self-reported emotional states [9]. The effectiveness of such mobile mental health applications has been increasingly supported by empirical research. In a randomized controlled trial, Economides et al. found that users of a mindfulness app (Headspace) who engaged in short, daily meditations reported significant reductions in stress and improvements in well-being after just ten sessions, suggesting that even brief interventions delivered digitally may yield measurable benefits [10].

Although mobile applications offer flexible and scalable solutions, their effectiveness often depends on engagement, structure, and the presence of support components—factors that have been identified as critical in broader digital interventions targeting youth [8].

- **Internet-based cognitive behavioral therapy (iCBT)**

Internet-based cognitive behavioral therapy (iCBT) refers to the delivery of structured CBT techniques via online platforms. These interventions replicate the core components of traditional CBT—such as behavioral activation, cognitive restructuring, and problem-solving—but are adapted to digital formats [11]. iCBT may be fully self-guided or include varying levels of professional support. Its growing popularity is largely due to its potential to reduce barriers to mental health care, including stigma, cost, and limited geographic access to therapists [11].

A recent meta-analysis by Wu et al. (2023), which reviewed 18 randomized controlled trials involving 1, 683 adolescents, confirmed that iCBT significantly reduced symptoms of depression (SMD = -0.42) and anxiety (SMD = -0.34) compared to control conditions. These findings suggest that iCBT can be an effective treatment, particularly for youth with mild to moderate symptoms [12].

A large randomized controlled trial by Furukawa et al. (2025) investigated the effectiveness of five distinct CBT components—behavioral activation, cognitive restructuring, problem solving, assertiveness training, and brief insomnia therapy—delivered through individual smartphone applications to 3, 936 adults with subthreshold depression. All five interventions produced significant reductions in depressive symptoms, as measured by the PHQ-9, and the effects were sustained for up to 26 weeks [13]. Although the study population consisted primarily of adults (mean age ~39 years), the findings may still hold relevance for adolescents and young adults, given their familiarity with smartphones and self-directed digital formats. However, caution is warranted when generalizing these results directly to younger populations, as developmental and motivational differences may affect engagement and outcomes.

Despite the promising evidence for iCBT, its implementation in real-world settings remains uneven. Access to iCBT programs varies significantly by region, with disparities often linked to broadband access, digital literacy, and language availability [14]. In many low- and middle-income countries, technological infrastructure and the availability of culturally adapted content are ongoing challenges [15]. Moreover, adolescents may face barriers such as lack of parental support, concerns about privacy, and difficulty navigating digital platforms without guidance [16]. These contextual factors should be carefully considered when evaluating the scalability of iCBT interventions.

- **Chatbots and Conversational AI Tools**

Chatbots and conversational artificial intelligence (AI) tools are digital systems developed to simulate human dialogue and deliver psychological support through interactive communication. While chatbots typically operate based on predefined scripts and decision trees, conversational AI refers to more sophisticated technologies that utilize natural language processing (NLP), deep learning algorithms, and user-generated data to generate adaptive, personalized, and context-aware responses. These tools have gained increasing attention in adolescent mental health care due to their potential to enhance accessibility, engagement, and responsiveness [17, 19-21].

Conversational AI tools support a wide spectrum of therapeutic and monitoring functions, including mood tracking, emotional regulation, cognitive restructuring, and psychoeducation. Unlike rule-based chatbots, AI-driven agents dynamically interpret linguistic cues, identify emotional tone through sentiment analysis, and adjust their responses in real time. Some advanced platforms even incorporate diagnostic components capable of predicting symptom escalation or treatment outcomes based on language and behavioral patterns [21].

A recent meta-analysis by Chen et al. (2025), which synthesized ten randomized controlled trials involving adolescents and young adults, confirmed the efficacy of chatbot-based interventions in reducing depressive symptoms (95% CI = –1.09 to –0.23; p =.003). However, no significant effect was found for anxiety symptoms (95% CI = –0.56 to 0.40; p =.74) [17]. In parallel, Cruz-Gonzalez et al. (2024) highlighted the diagnostic potential of AI systems, particularly those employing support vector machines, random forest models, and neural networks, in the classification and prediction of mental health conditions [21].

The design and development of mental health chatbots and AI tools are critical determinants of their usability and clinical utility. Grové et al. (2021) underscored the necessity of participatory design, emphasizing that tools co-created with adolescents exhibit greater linguistic appropriateness, engagement, and cultural alignment [20].

A randomized controlled trial conducted by Matheson et al. (2023) in Brazil assessed *Topity*, a chatbot delivering brief microinterventions focused on body image and well-being. Participants using the chatbot reported small but statistically significant improvements in both state and trait body image, affect, and self-efficacy—particularly among individuals with heightened baseline vulnerability. The intervention

incorporated media literacy, cognitive-behavioral strategies, and positive body image theory, embedded within a gamified conversational structure [19].

More recently, Obadinma et al. (2025) developed and evaluated *FAIIR*, a conversational AI system designed to support frontline crisis responders in youth mental health services. Trained on over 780, 000 real-world support conversations, FAIIR leverages transformer-based language models to detect psychological risk, prioritize urgent cases, and streamline post-conversation documentation. The tool demonstrated high predictive validity (AUC-ROC = 94%, F1-score = 64%, recall = 81%), and its recommendations aligned with human judgments in 90.9% of cases—surpassing agreement with original labels. These results highlight the triage and decision-support capabilities of advanced conversational AI in mental health contexts [22].

Beyond intervention, conversational AI is being actively explored for its diagnostic and monitoring applications. Schick et al. (2022) demonstrated that chatbot-administered mental health assessments yielded results comparable to conventional self-report tools, without increasing socially desirable responding. However, users reported slightly greater cognitive effort, suggesting potential trade-offs in usability [18].

In summary, the current evidence supports the use of both chatbots and conversational AI as scalable and accessible tools for addressing adolescent mental health concerns, particularly depression and body image issues. Nevertheless, challenges persist in relation to anxiety-specific outcomes, sustained user engagement, algorithmic transparency, and the cultural adaptability of these technologies [17, 19-22].

- **Gamified and VR-Based Interventions**

Gamified interventions and virtual reality (VR)-based tools have emerged as engaging digital strategies aimed at improving adolescent mental health by enhancing motivation, emotional regulation, and cognitive engagement. Gamification elements such as narratives, avatars, progress tracking, and reward systems are commonly used to increase user adherence and promote therapeutic outcomes [23]. A scoping review by Norlund et al. (2023) identified that gamified interventions targeting children and adolescents often integrate theoretical frameworks including CBT, emotion regulation, and social skills training, and are associated with improved psychosocial functioning and reduced depressive or anxious symptoms [24].

Several studies suggest that such interventions are particularly effective when designed with high interactivity and a clear connection between game elements and therapeutic goals. For instance, Park et al. (2021) demonstrated that a gamified mobile CBT app significantly reduced depressive symptoms in adolescents after a 4-week intervention [25]. Similarly, in the study by Calvo et al. (2020), a mobile game based on behavioral activation showed high acceptability and potential efficacy in reducing depressive symptoms in young users [26].

VR-based tools, although less prevalent, have shown promise in immersive therapeutic scenarios. Virtual environments allow users to rehearse coping skills, face feared situations in a safe context, or receive biofeedback-enhanced mindfulness training [27]. In particular, VR interventions that simulate social interactions or emotion regulation tasks were associated with improved anxiety management and emotional awareness [27].

Moreover, design quality and age-appropriate content significantly influence the effectiveness of these interventions. Research by Lau et al. (2021) emphasizes the importance of tailoring narrative and reward systems to developmental stages and cultural contexts to ensure engagement and relevance [28]. Despite promising findings, current studies often report small sample sizes and limited follow-up periods, indicating the need for more robust trials to evaluate long-term efficacy and implementation feasibility [24, 29].

Collectively, evidence supports the utility of gamified and VR-based interventions in promoting mental health among adolescents, particularly when aligned with psychological theory, co-designed with youth, and delivered with sustained interactivity [23-29].

- **Digital Peer Support and Social Platforms**

Digital peer support interventions and social platforms have become increasingly prominent in adolescent mental health strategies, offering scalable, youth-friendly formats that facilitate emotional expression, validation, and help-seeking [30-32]. These interventions may be delivered through structured web-based platforms, moderated forums, mobile applications, or social media communities, often operating without direct professional facilitation [32, 33]. Evidence indicates that peer-driven approaches can promote emotional well-being by leveraging familiarity with digital communication and a shared understanding of adolescent experiences [30, 31].

A randomized controlled trial conducted during the COVID-19 pandemic demonstrated that adolescents who received online peer support training showed significant improvements in perceived emotional support, psychological agency, and mental health outcomes compared to controls [30]. These results suggest that structured peer-led programs can strengthen protective factors in youth, especially in crisis settings. Similarly, a historical overview of peer support initiatives in the U.S. emphasized that online delivery has enabled broader reach while maintaining core values of empathy and shared experience [33].

Digital peer support is also being adapted to mobile and app-based formats in public health systems. According to a qualitative study in U.S. community clinics, adolescents expressed strong preferences for mHealth interventions that include peer-based coaching, citing perceived relatability and reduced stigma as key motivators for engagement [31]. Young users reported greater openness when interacting with non-clinicians or near-age peers, especially when discussing sensitive emotional topics.

Social platforms themselves may also serve as informal environments for peer support, though the effects can be bidirectional. A scoping review by Hoare et al. (2023) found that social media use among adolescents is linked with both increased depression and perceived social connection, depending on individual differences in usage patterns, emotional regulation, and susceptibility to comparison or cyberbullying [32]. Similarly, a recent review emphasized that social media may both help and harm youth mental health, depending on the nature of engagement—such as supportive messaging versus exposure to psychiatric contagion or harmful trends [34].

Formalized digital peer support interventions embedded in university settings have also demonstrated promising results. In one randomized controlled trial, an online program grounded in acceptance and commitment therapy significantly reduced symptoms of anxiety, depression, and stress in university students compared to a control group [35]. These findings align with broader evidence suggesting that peer support can serve as a valuable adjunct to traditional mental health services, enhancing accessibility and resonance among youth populations.

In sum, the literature supports the effectiveness of digital peer support and social platforms in improving mental health outcomes among adolescents, particularly when interventions are co-designed with youth, moderated to ensure safety, and framed within evidence-based therapeutic models [30-35].

3. Conclusions

Digital mental health interventions, including mobile applications, internet-based cognitive behavioral therapy (iCBT), conversational AI tools, gamified platforms, and peer-support systems, represent promising avenues for addressing the rising prevalence of depression and anxiety among adolescents. Current evidence supports the effectiveness of these interventions in reducing depressive symptoms, improving emotional regulation, and enhancing engagement with mental health support. While findings related to anxiety are more variable, select tools have shown potential benefits, particularly when integrated with established therapeutic frameworks.

The accessibility, anonymity, and flexibility of digital formats contribute to their growing appeal among adolescents, especially in overcoming barriers such as stigma, cost, and limited availability of traditional services. Nevertheless, challenges remain regarding sustained user engagement, cultural and developmental appropriateness, data privacy, and clinical validation. Evidence also highlights significant disparities in access to technology and the need for more inclusive, co-designed solutions tailored to diverse populations.

To advance the field, future research should prioritize rigorous, long-term evaluations of digital tools, including hybrid approaches that combine automated and human-guided components. There is also a need for transparent reporting of outcomes, development of standardized guidelines for digital intervention design, and broader policy support to integrate digital mental health care into public health systems and educational settings. Addressing these areas will be critical in harnessing the full potential of digital innovation to support adolescent mental well-being on a population level.

Disclosure

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