

REVIEW ARTICLE

The impact of mobile mental health interventions on depressive and anxiety symptoms among university students: A scoping review

Junting Mu, Pei Sun*

Faculty of Health and Wellness, City University of Macau, Macau 999078, China

ABSTRACT

Globally, mental health problems such as depression and anxiety have become increasingly prominent among university students, posing serious threats to their academic performance, social functioning, and personal development. Traditional mental health service models face numerous challenges, including resource scarcity, poor accessibility, and stigmatization, making it difficult to meet the substantial demand. This scoping review aims to systematically evaluate the effectiveness of mobile mental health interventions (mMHIs) in reducing depressive and anxiety symptoms among university students, identify key influencing factors, and explore the limitations of existing research as well as future directions. Following the PRISMA-ScR reporting guidelines, this study conducted a systematic review of relevant literature through structured processes of searching, screening, eligibility assessment, and data extraction, ultimately including 53 articles for analysis. The review reveals that mMHIs, particularly applications based on cognitive behavioral therapy and mindfulness, demonstrate significant potential in improving depressive and anxiety symptoms among university students. The findings indicate that these interventions can effectively alleviate symptoms, enhance psychological resilience and well-being, and exhibit high levels of acceptability and feasibility. However, challenges related to user engagement and retention rates, heterogeneity in intervention effects, and the need for in-depth research on specific cultural contexts and long-term outcomes remain critical areas requiring future attention. This review not only synthesizes the evidence from current research but also identifies gaps in the existing knowledge base, providing important insights for future research directions and practical applications.

Keywords: mobile mental health interventions, university students, depression, anxiety, effectiveness, scoping review

INTRODUCTION


In the contemporary era of globalization, university students, as the future pillars of society, are confronting unprecedented mental health challenges. Psychological problems such as depression and anxiety have become increasingly prominent within this population. The study by Conley *et al.* (2024) emphasizes that approximately 40% of college students suffer from anxiety or depression, which not only affects their academic performance but may also lead to social impairment, decreased quality of life, and even increased suicide risk.

This high prevalence rate not only poses a threat to the healthy development of individual students but also presents severe challenges to the health service systems of higher education institutions. The pervasiveness of mental health problems among college students makes the need for effective intervention measures increasingly urgent. These issues not only interfere with academic performance, social interactions, and personal development but may also evolve into long-term mental health disorders and even precipitate extreme consequences such as suicide risk. Particularly in the post-pandemic era, remote learning and social isolation

***Corresponding Author:**Pei Sun, Faculty of Health and Wellness, City University of Macau, Macau 999078, China. Email: peisun@cityu.edu.mo; <https://orcid.org/0000-0002-5938-8180>

Received: 13 January 2026; Revised: 14 March 2026; Accepted: 26 March 2026

<https://doi.org/10.54844/wsr.2026.1139>

 This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License, which allows others to copy and redistribute the material in any medium or format non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

have further exacerbated these problems, prompting researchers and practitioners to seek innovative solutions. Mobile mental health interventions (mMHIs), as intervention modalities delivered through smartphone applications and digital platforms, are emerging as potential instruments for addressing this crisis due to their convenience and scalability. However, despite preliminary evidence indicating their positive effects, the fragmentation and heterogeneity of existing research continue to hinder their comprehensive application in policy and practice. Through a scoping review methodology, this study systematically evaluates the effectiveness of mMHIs in reducing depressive and anxiety symptoms among university students, aiming to fill knowledge gaps and provide guidance for future research.

The value and significance of mMHIs lie in their capacity to transcend the limitations of traditional mental health services. Traditional mental health services are often constrained by insufficient resources, geographical restrictions, prohibitive costs, and pervasive stigmatization. Many university students refrain from seeking professional help due to concerns about labeling, privacy breaches, or financial burdens (Kählke et al., 2024; Salamanca-Sanabria et al., 2023). In contrast, mMHIs leverage mobile technology to provide anytime, anywhere support—for instance, cognitive behavioral therapy (CBT)-based applications or mindfulness meditation tools—which can significantly enhance service accessibility and privacy. This not only contributes to symptom alleviation but also improves psychological resilience and overall well-being. More importantly, the interactive relationships between mMHIs and key variables have attracted considerable attention. For example, they are closely associated with academic stress, social media use, and levels of social support. Research demonstrates that university students experiencing high academic stress can reduce anxiety levels by 20%-40% through mMHIs (Mantani et al., 2017), while integration with social media may amplify their impact but also introduce risks of digital fatigue. Additionally, mMHIs interact with demographic variables such as gender, age, and cultural background, with female and minority students often deriving greater benefits yet also facing higher attrition rates. These relationships underscore the multidimensional impact of mMHIs, extending beyond symptom relief to encompass preventive interventions and long-term well-being.

Statistics indicate that the global mobile mental health market continues to expand, with projections of sustained rapid growth in the coming years. Among various mobile mental health applications, mental health-focused apps constitute a significant proportion, with both download volumes and usage rates demonstrating marked upward trends (Malhotra, 2023).

However, significant gaps exist in the current literature. First, there is insufficient cultural adaptation, as most studies focus on Western contexts, neglecting the unique needs of university students in Asia or developing countries, such as stigmatization issues within collectivist cultures. Second, methodological heterogeneity makes intervention effects difficult to compare due to sample diversity and variations in measurement instruments. Third, long-term outcome assessments are lacking, with many studies focusing solely on short-term outcomes while overlooking symptom relapse risks. Furthermore, low user engagement and retention rates (with average retention rates below 50%) have become pervasive challenges, highlighting the necessity for design optimization and personalized interventions. These trends and gaps not only reflect the rapid development of the field but also expose the fragility of the evidence base, urgently requiring systematic integration to guide practice.

Based on the aforementioned background, this scoping review aims to systematically map and evaluate existing evidence on mMHIs in reducing depressive and anxiety symptoms among university students, identify key influencing factors and research gaps, and provide directional guidance for future research and practical applications. In this study, we adhere to the PRISMA-ScR guidelines, conducting systematic searches and analyses of the global literature to clarify the effectiveness of mMHIs, influencing factors, and future directions. This endeavor not only provides empirical evidence for educational institutions and policymakers but also promotes interdisciplinary collaboration, integrating perspectives from psychology, technology, and public health.

METHODOLOGY

This scoping review was conducted in accordance with the PRISMA-ScR guidelines. A systematic literature search was performed using PubMed/MEDLINE, Web of Science Core Collection, and Scopus databases to identify potentially relevant studies. A comprehensive search strategy combining multiple keywords and Boolean operators was employed, with specific search terms detailed in Table 1. Conference papers, book chapters, and non-English publications were excluded from consideration. The eligibility criteria for study selection in this scoping review are presented in Table 2.

RESULTS

The initial search yielded a total of 419 articles. After removing duplicates, 410 articles remained. Following title and abstract screening, 308 irrelevant articles were excluded. Full-text assessment was conducted on the remaining 102 articles, ultimately resulting in the

Table 1: Search strategy keywords

Keyword category	Keywords
Study population	"college student" OR "university student" OR "undergraduate" OR "young adult"
Intervention type	"mobile health" OR "mHealth" OR "smartphone" OR "mobile app" OR "mobile application" OR "digital intervention" OR "mobile intervention"
Outcome measures	"depression" OR "depressive symptom" OR "anxiety" OR "anxiety symptom" OR "mental health" OR "psychological distress"

Table 2: Inclusion and exclusion criteria

Category	Specific criteria
Inclusion criteria	<p>Study population: University students and young adult (undergraduates or graduate students, typically aged 18–25 years);</p> <p>Intervention type: mMHI, including smartphone applications, mobile websites, text messaging, or any digital interventions delivered <i>via</i> mobile devices;</p> <p>Outcome measures: Assessment of improvements in depressive and/or anxiety symptoms using standardized assessment tools (<i>e.g.</i>, Patient health questionnaire-9, Generalized anxiety disorder-7, Beck depression inventory, Beck anxiety inventory);</p> <p>Study design: Randomized controlled trials, quasi-experimental studies, pre-post studies, meta-analyses, systematic reviews;</p> <p>Publication period: January 2015 to December 2025;</p> <p>Language: peer-reviewed literature published in English</p>
Exclusion criteria	<p>Studies with non-university student populations or mixed samples without separate extraction of university student data;</p> <p>Studies focusing exclusively on other mental disorders (<i>e.g.</i>, schizophrenia, bipolar disorder);</p> <p>Interventions delivered <i>via</i> non-mobile platforms (<i>e.g.</i>, computer-based online interventions only);</p> <p>Conference abstracts, dissertations, grey literature;</p> <p>Studies for which full text was unavailable</p>

inclusion of 53 articles in this review (Figure 1).

Overall effectiveness of mMHI

Multiple studies and meta-analyses have demonstrated that mMHI have positive effects on reducing depressive symptoms, though the strength and consistency of these effects vary. The meta-analysis by Linardon *et al.* (2019) found that smartphone interventions could significantly improve depressive symptoms. The meta-analysis by Weisel *et al.* (2019) also found significant effects of standalone smartphone applications on depression. The systematic review and meta-analysis by Serrano-Ripoll *et al.* (2022) indicated that smartphone-based psychological interventions could moderately reduce depressive symptoms, with more pronounced effects observed in patients with moderate to severe depression. The meta-analysis by Luo *et al.* (2024), which included 46 studies, found that mental health applications had small to moderate effect sizes for depression treatment, with intervention durations exceeding 8 weeks yielding the greatest symptom reduction.

Studies specifically targeting university student populations have also reported positive outcomes. The randomized controlled trial by Vereschagin *et al.* (2024) evaluated the Minder mobile application and found significant reductions in depressive symptoms among university students in the intervention group. The randomized controlled trial by Litvin *et al.* (2023) found that the gamified mental health application eQuoo significantly reduced anxiety and depression scores among

students. The randomized controlled trial by Fuller *et al.* (2025) found that a gratitude-based smartphone application significantly reduced depression, anxiety, and stress among university students with moderate to severe psychological distress. The randomized controlled trial by Conley *et al.* (2024) demonstrated that technology-assisted mindfulness interventions could reduce depressive symptoms and psychological distress in depressed university student populations. The randomized controlled trial by Lin *et al.* (2024) found that CBT-based mobile applications significantly reduced depressive symptoms among university students. The study by Barati *et al.* (2025) found that mobile application-based positive activity interventions could significantly improve well-being and reduce depression among university students. CBT-based interventions are considered a core effective approach. The randomized controlled trial by Mantani *et al.* (2017) found that smartphone CBT applications, as an adjunct to pharmacological treatment, could significantly reduce depression severity in patients with treatment-resistant depression. The randomized controlled trial by Chan *et al.* (2021) also demonstrated that smartphone-delivered self-help CBT for insomnia (CBT-I) could effectively treat major depression accompanied by insomnia.

Similar to depressive symptoms, mMHI have also demonstrated significant effectiveness in reducing anxiety symptoms. The meta-analysis by Linardon *et al.* (2019) found that smartphone interventions could significantly improve generalized anxiety and social anxiety symptoms. The meta-analysis by Lu *et al.* (2022) found

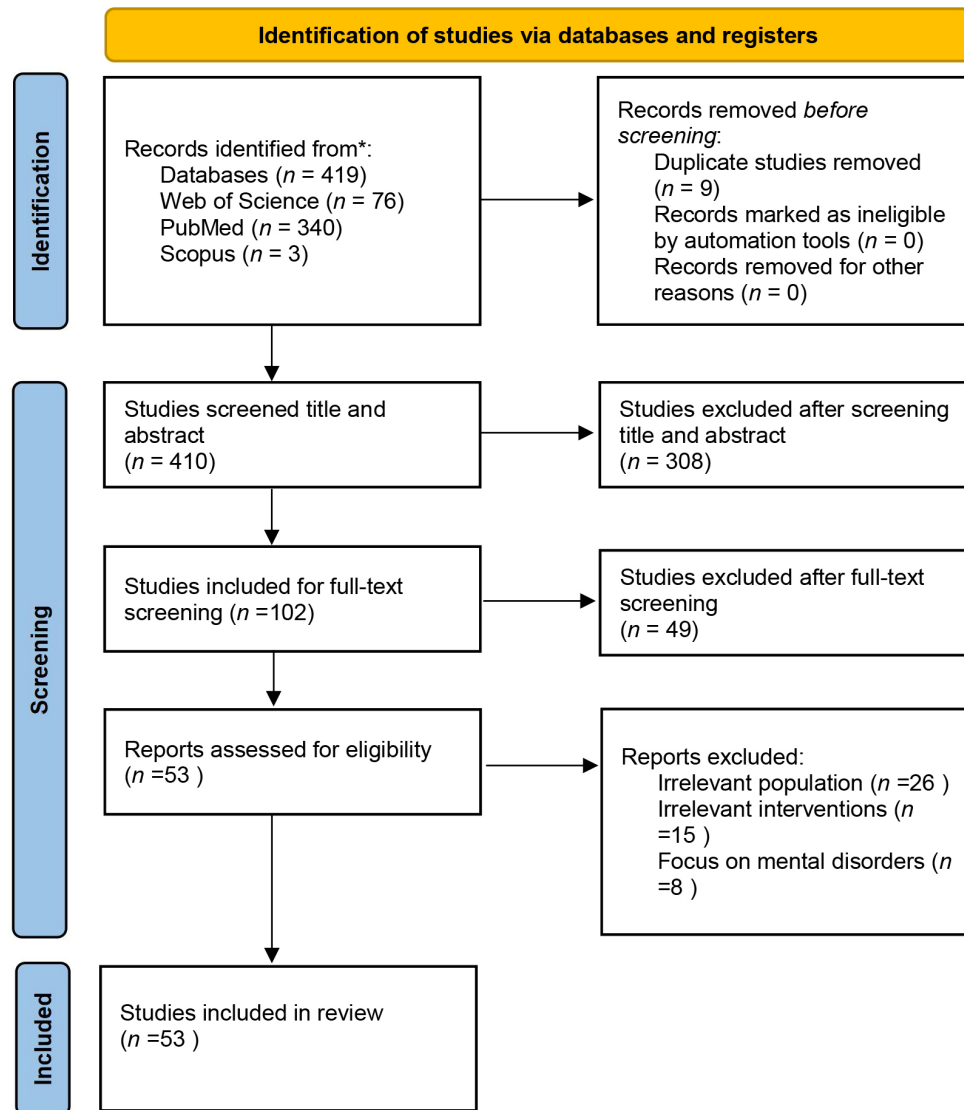


Figure 1. Prisma flow diagram. *Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers). (reuse from Page MJ, *et al.* BMJ 2021;372:n71. doi: 10.1136/bmj.n71).

that app-based mMHI had significant reducing effects on anxiety symptoms. The meta-analysis by Ebert *et al.* (2015) found that internet- and computer-based CBT was effective for anxiety and depression in adolescents, with an effect size of 0.68 for anxiety.

Studies targeting university students similarly support these findings. The randomized controlled trial by Litvin *et al.* (2023) also reported that the eQuoo application significantly reduced anxiety scores among students. The study by Fuller *et al.* (2025) found that the gratitude-based application significantly reduced anxiety among university students. The randomized controlled trial by Sun *et al.* (2022) found that during quarantine, mindfulness-based mMHI were superior to social support mMHI in reducing anxiety among Chinese

university students. The pilot study by Bangalan & Agnes (2025) also demonstrated that the AKBAY mobile application could significantly reduce anxiety symptoms among university students. The randomized controlled trial by Lee *et al.* (2024) found that the mobile mental health application Intellect could effectively improve subclinical obsessive-compulsive symptoms among university students. Interventions based on CBT and mindfulness showed particularly strong performance in reducing anxiety. The randomized controlled trial by Lu *et al.* (2023) found that web- and mobile-based Acceptance and Commitment Therapy (ACT) interventions could significantly improve anxiety symptoms in nurses (d = 0.67). The randomized controlled trial by Kosasih *et al.* (2023) evaluated a CBT-based mobile mental health anxiety and worry program and found

significant improvements in anxiety and depressive symptoms in the intervention group.

In addition to depression and anxiety, mMHIIs also produce positive effects on other mental health indicators. Multiple studies have reported that mMHIIs can effectively reduce stress. Linardon *et al.* (2019) found that smartphone interventions could improve stress. The eQuoo application by Litvin *et al.* (2023) significantly reduced student stress. The gratitude application by Fuller *et al.* (2025) also reduced stress among university students. The study by Conley *et al.* (2024) showed that technology-assisted mindfulness interventions could increase positive affect, well-being, savoring capacity, compassion, self-regulation, and trait mindfulness. The study by Barati *et al.* (2025) found that mobile application-based positive activity interventions could significantly improve well-being among university students. The study by Laure *et al.* (2024) found that mobile application interventions targeting emotion regulation skills in university students could increase positive emotional states, reduce negative emotions, and improve emotion regulation skills. The study by Vereschagin *et al.* (2024) found that in addition to improving mental health, the Minder application could also reduce the frequency of cannabis and alcohol use among university students.

Some studies have explored factors influencing the effectiveness of mMHIIs. Lu *et al.* (2022) found that interventions lasting at least 7 weeks had greater effects, but Bae *et al.* (2023) found that shorter interventions (≤ 8 weeks) were more effective for moderate to severe depression, suggesting that optimal duration may vary depending on symptoms and severity. Linardon *et al.* (2019) found that guided CBT applications could produce greater effects. The meta-analysis by Heber *et al.* (2017) also indicated that guided interventions (Cohen's $d = 0.64$) were more effective than unguided interventions (Cohen's $d = 0.33$). Serrano-Ripoll *et al.* (2022) found that application interventions were more effective for patients with moderate to severe depression. The study by Ly *et al.* (2014) found that behavioral activation was more effective for patients with higher initial depression severity, while mindfulness was more effective for patients with lower initial severity. The study by Kosasih *et al.* (2023) found that higher application engagement predicted lower symptom levels.

Overall, existing evidence supports the effectiveness of mMHIIs in reducing depressive and anxiety symptoms among university students, particularly in CBT- and mindfulness-based interventions. However, the heterogeneity of intervention effects, applicability to specific subpopulations, and assessment of long-term effects still require not more high-quality research for clarification (Table 3).

Key factors influencing the effectiveness of mMHIIs

The effectiveness of mMHIIs is not determined by a single factor, but rather by the combined influence of multiple complex factors. An in-depth understanding of these key factors is crucial for optimizing the design of mMHIIs, improving their clinical translation, and enhancing user adherence.

Intervention type and theoretical foundation

The effectiveness of mMHIIs is closely related to the psychological theories and intervention types on which they are based. Currently, CBT and mindfulness are the two most widely applied and significantly effective theoretical foundations in mMHIIs.

Based on psychological therapy theories: Most effective mobile mental health applications explicitly state that their content is based on established psychological therapy theories, particularly CBT and mindfulness. For example, the meta-analysis by Linardon *et al.* (2019) indicated that CBT-based applications could produce greater effects when guided. The Maya application by Bress *et al.* (2024) is a CBT-based mobile intervention for treating anxiety disorders in young adults. The retrospective analysis by Fundoiano-Hershcovitz *et al.* (2023) also found that CBT-based digital therapeutic tools could significantly reduce depressive and anxiety symptoms. The study by Conley *et al.* (2024) evaluated Headspace, a technology-assisted mindfulness intervention.

Personalization and adaptiveness: With the development of artificial intelligence and machine learning technologies, an increasing number of mobile mental health applications have begun to provide personalized content and adaptive interventions. Zainal *et al.* (2025) discussed the potential of Just-In-Time Adaptive Interventions (JITAIIs) to deliver personalized, real-time interventions through mobile health technologies.

Gamified interventions: To enhance user engagement and adherence, many applications have incorporated gamified design. Studies by Litvin *et al.* (2023) and Litvin *et al.* (2020) both evaluated the gamified mental health application eQuoo and found that it could significantly improve psychological resilience, reduce anxiety and depression, and effectively reduce user attrition.

Guidance and support: The degree of guidance in interventions is an important factor affecting effectiveness. Linardon *et al.* (2019) found that guided CBT applications could produce greater effects. The study by K uchler *et al.* (2023) compared internet and mobile mindfulness interventions with "on-demand guidance" versus without guidance, and found that the guided

Table 3: Summary of effect sizes across different types of mobile mental health interventions (mMHIs)

Study	Intervention type	Theoretical framework	Sample	Study design	Follow-up duration	Key outcome measures	Effect size
Linardon <i>et al.</i> (2019)	Smartphone apps (with guided CBT)	CBT	University students; community adults	Meta-analysis ($n = 66$)	7–11 weeks (optimal)	Depression, anxiety, stress	Significant improvement (depression $d = 0.28$; anxiety $d = 0.30$; stress $d = 0.35$)
Y. Lin <i>et al.</i> (2024)	CBT mobile app (culturally adapted version)	CBT	University students ($n = 91$)	RCT	4 weeks (optimal)	Depressive symptoms	Significant improvement
Kosasih <i>et al.</i> (2023)	Self-guided mobile health app Intellect (anxiety and worry program)	CBT	University students ($n = 323$)	RCT (with active control)	2-week follow-up	Anxiety, depressive symptoms	Significant improvement; higher engagement predicted lower symptom levels (overall effect size $g = 0.28-0.38$)
Serrano-Ripoll <i>et al.</i> (2022)	Smartphone-based psychological intervention	Multiple theories (CBT-predominant)	Adults with depressive symptoms ($n = 2,859$)	Systematic review and meta-analysis	4–12 weeks	Depressive symptoms	Moderate effect; more pronounced for moderate-to-severe depression (SMD = -0.67)
Lu <i>et al.</i> (2022)	App-based mobile health intervention	Multiple theories (CBT-predominant)	Adults with anxiety and depression ($n = 1,942$)	Systematic review and meta-analysis	More pronounced at ≥ 7 weeks	Anxiety, depressive symptoms	Significant reduction (minimum effective dose ≥ 7 weeks)
Conley <i>et al.</i> (2024)	Headspace (mindfulness-based intervention)	Mindfulness	University students with depression ($n = 145$)	RCT	3 months	Depression, psychological distress, positive affect, well-being	Significant improvement
Litvin <i>et al.</i> (2023)	Gamified mobile mental health app eQuoo	CBT, positive psychology, systemic therapy	University students ($n = 1,165$)	RCT	No long-term follow-up	Anxiety, depression, resilience	Moderate effect sizes (resilience $d = 0.58$; anxiety $d = 0.60$; depression $d = 0.58$); significant improvement
Fuller <i>et al.</i> (2025)	iOS smartphone-based gratitude intervention	Positive psychology (Gratitude)	University students with moderate-to-severe psychological distress ($n = 120$)	RCT	No long-term follow-up	Depression, anxiety, stress	Significant improvement ($d = -0.68$)
Vereschagin <i>et al.</i> (2024)	Minder app	CBT, psychoeducation	University students ($n = 1,489$)	RCT	30 days	Anxiety, depression	Small effect sizes (anxiety $d = -0.17$; depression $d = -0.11$); significant improvement

CBT, cognitive behavioral therapy; mMHI, mobile mental health intervention; RCT, randomized controlled trial; NR, not reported; SMD = standardized mean difference; cCBT, computerized CBT; iCBT, internet-based CBT; mCBT, mobile CBT; CBT-I, CBT for insomnia. Effect sizes are reported as Cohen's d unless otherwise indicated. g refers to Hedges' g ; β refers to standardized regression coefficient.

group had higher adherence. This guidance can be provided by human coaches or implemented through chatbots or intelligent algorithms.

Cultural adaptability: For users from different cultural backgrounds, the cultural adaptability of applications has become increasingly important. Zannat & Mahmud (2025) developed an Islamic-style digital therapy application to address cultural sensitivity issues among Muslim university students. Studies by Listiyandini *et al.* (2023) and Balci *et al.* (2024) also emphasized the importance of cultural adaptation for Indonesian and Turkish university students.

Overall assessment: CBT and mindfulness are the most mature and significantly effective theoretical foundations in mMHIs, while gamification and positive psychology interventions have demonstrated tremendous potential in enhancing engagement and promoting positive mental

health. Different intervention types each have their own focus: CBT provides structured skills training, mindfulness cultivates emotional regulation abilities, gamification enhances adherence, and positive psychology directly improves well-being. Future research can explore the integration of different theoretical foundations with the aim of achieving more comprehensive and lasting intervention effects.

Core functional module analysis

Mobile mental health applications typically include the following core functional modules to achieve their intervention objectives. (1) Psychoeducation module. Provides knowledge about depression, anxiety, stress management, emotional regulation, and other aspects, helping users understand their symptoms and coping strategies. For example, the LvL UP 1.0 application developed by Castro *et al.* (2023) includes health literacy and psychoeducation coaching modules. (2) Self-help

practices and tools. This is the core of mobile mental health applications, including a. Cognitive restructuring exercises: Identifying and challenging negative thinking, such as thought records and cognitive distortion identification. b. Behavioral activation exercises: Encouraging users to engage in pleasant or meaningful activities to combat behavioral withdrawal caused by depression. c. Mindfulness and relaxation techniques: Guided meditation, deep breathing exercises, progressive muscle relaxation, *etc.*, used to reduce anxiety and stress. Jeong *et al.* (2024) introduced a biofeedback-based deep breathing DTx mobile application. The study by Borjalilu (2023) also used a mindfulness-based stress management application. d. Mood tracking and journaling: Allowing users to record daily emotions, activities, and thoughts, helping them identify patterns and increase self-awareness. The mobile type program by Reid *et al.* (2011) was used to monitor mood, stress, and daily activities. e. Gratitude practices: Encouraging users to record things they are grateful for to enhance positive emotions. The study by Fuller *et al.* (2025) tested a gratitude-based smartphone application. (3) Biofeedback and physiological monitoring: Some applications integrate sensor data (such as heart rate variability) to provide real-time physiological feedback, helping users learn relaxation techniques. Studies by Jeong *et al.* (2024) and Kerr *et al.* (2023) both involved biofeedback technology. (4) Chatbots and virtual coaches: Provide instant, personalized conversational support, answer user questions, guide exercises, and provide encouragement. Studies by Omarov *et al.* (2023), Gupta *et al.*, (2023), Isa (2024) all emphasized the role of AI chatbots in mental health support. The systematic review by Gaffney *et al.* (2019) also explored the application of conversational agents in the treatment of mental health issues, finding them promising in alleviating psychological distress. (5) Community and social support: Allows users to interact with other users in a safe environment, share experiences, and provide and receive support. The study by Salamanca-Sanabria *et al.* (2023) found that university students believe mMHI should include peer support. (6) Progress tracking and feedback: Visualizes user progress, provides a sense of achievement and motivation, and helps maintain engagement. The review by Kersten-van Dijk *et al.* (2017) emphasized the importance of personal informatics, self-insight, and behavior change. (7) Emergency support: Provides crisis hotline and emergency contact information, ensuring users can access professional help when needed. Torous *et al.* (2018) pointed out that the lack of emergency support is one of the challenges faced by mobile mental health applications.

The combination and implementation of these functional modules collectively determine the effectiveness and user experience of mMHI. Research shows

that applications with more engagement features typically produce greater effects, but not all persuasive design (PSD) features are positively correlated with engagement, suggesting that application design requires more refined consideration (Wu *et al.*, 2021).

User engagement and retention

User engagement and retention rates are key determinants of whether mMHI can achieve practical effects. Even if an intervention has a strong theoretical foundation and potential efficacy, its clinical value will be significantly diminished if users do not use it or cannot sustain its use. This review found that user engagement and retention are prevalent challenges in the mobile mental health field, but some strategies have been proven effective in improving these metrics.

Multiple studies have pointed out that mobile mental health applications generally have high user attrition rates. The systematic meta-analysis by Linardon & Fuller-Tyszkiewicz (2020) found that smartphone interventions had a short-term attrition rate of 24.1% and a long-term attrition rate of 35.5%, with app usage showing a declining trend during the trial period. The literature review by Amagai *et al.* (2022) also emphasized the challenge of participant attrition in mobile mental health app research, noting that the likelihood of attrition is higher than retention. Nwosu *et al.* (2022) called user attrition the "Achilles' heel" of digital therapeutics, emphasizing its prevalence and importance in mental health digital therapeutics. Many users may only use the app a few times after downloading before abandoning it. The study by Wu *et al.* (2021) found that although digital mental health apps can reduce depression and anxiety symptoms, sustained use is rare. The systematic review by Milne-Ives *et al.* (2019) also pointed out that despite users' positive perceptions of mobile applications and high engagement and usability scores, there is little evidence that they lead to behavioral change or health outcomes, which may be related to underuse. User engagement is influenced by multiple factors, including app design, intervention content, user characteristics, and external support.

Researchers have explored various strategies to improve user engagement and retention rates in mMHI: (1) Gamification design: Integrating game elements into applications is considered an effective means of increasing engagement. Studies by Litvin *et al.* (2023) and Litvin *et al.* (2020) both found that the gamified mental health app eQuoo significantly improved user adherence (64.5%) and retained more participants (42% more than the control group). (2) Personalization and adaptive intervention: Providing personalized content and immediate adaptive interventions that are highly matched to users' needs and conditions can significantly

enhance user relevance and appeal. Zainal *et al.* (2025) discussed the potential of JITAIs in enhancing accessibility and engagement. The study by Fundoiano-Hershovitz *et al.* (2023) also emphasized the importance of personalized engagement strategies in digital health interventions. (3) Guidance and support: Human guidance or intelligent guidance (such as chatbots) can significantly improve user adherence. Linardon *et al.* (2019) found that guided CBT apps produced greater effects. The study by K uchler *et al.* (2023) found that the "on-demand guidance" group had higher adherence than the no-guidance group. (4) Incentive mechanisms: Providing appropriate incentives, such as monetary compensation, can reduce attrition rates. The meta-analysis by Linardon & Fuller-Tyszkiewicz (2020) found that monetary compensation was associated with lower attrition rates. (5) User-centered design and cultural adaptation: Fully considering the needs, preferences, and cultural backgrounds of target users during app development, and conducting user-centered design and cultural adaptation, can improve app acceptance and relevance. The qualitative study by Salamanca-Sanabria *et al.* (2023) found that university students want mMHIIs to be personalized and manage adverse events. The study by Mudau *et al.* (2024) also emphasized that convenient, accessible, confidential, and non-pathologizing apps are feasible for South African university students. Willis & Neblett (2023) emphasized the urgent need to develop culturally adapted mMHIIs for African American young adults. (6) Notifications and reminders: Appropriate notifications and reminders can prompt users to return to the app. The meta-analysis by Linardon & Fuller-Tyszkiewicz (2020) found that reminders were associated with lower attrition rates. However, the study by Bae *et al.* (2023) found that in-app notifications were associated with lower therapeutic effects, suggesting that the frequency and content of notifications need to be carefully designed to avoid excessive disruption. (7) Simple and clear interface and content: Apps that are easy to use, visually appealing, and have concise and clear content are more likely to be accepted and continuously used by users. The usability study by Dur an *et al.* (2023) found that the uMind app received positive feedback in navigation, usability, functionality, and design. (8) Integration into daily life: Seamlessly integrating mMHIIs into users' daily lives, making them part of their habits rather than an additional burden. The systematic review by Arroyo & Zawadzki (2022) found that common behavior change techniques in mobile mental health sleep apps include feedback, monitoring, shaping knowledge, goals and planning, all of which help integrate behaviors.

Despite these strategies showing potential, user engagement and retention rates remain an ongoing challenge in the mobile mental health field. Future

research needs to explore more deeply the combined effects of different strategies and develop more advanced technologies, such as machine learning to predict user attrition, Wang *et al.*, (2025), in order to achieve more sustained user engagement.

DISCUSSION

Main findings

This scoping review systematically searched and analyzed empirical studies on mMHIIs in the management of depression and anxiety symptoms among college students, published between 2015–2024. The review results indicate that mMHIIs demonstrate small to moderate efficacy in alleviating depression and anxiety symptoms in college students (effect size $d = 0.33–0.68$), with interventions based on CBT and mindfulness being particularly prominent. However, existing research simultaneously reveals multiple challenges facing this field, including insufficient user engagement, significant effect heterogeneity, lack of long-term efficacy evidence, and inadequate cultural adaptation research.

Specifically, the core findings of this review can be summarized into the following five aspects: First, efficacy evidence. Multiple meta-analyses and randomized controlled trials confirm that mMHIIs can significantly improve depression and anxiety symptoms in college students, with effect sizes ranging from small to moderate (Linardon *et al.*, 2019; Weisel *et al.*, 2019). CBT-based and mindfulness-based interventions demonstrate strong clinical value in symptom relief, psychological resilience enhancement, and well-being improvement. Second, key moderating factors. Intervention effects are significantly moderated by multiple factors. Research shows that interventions lasting more than 7–8 weeks have more significant therapeutic effects (Luo *et al.*, 2024; Lu *et al.*, 2022); guided interventions are superior to fully self-help interventions (Linardon *et al.*, 2019; Heber *et al.*, 2017); Gamification design can significantly improve user engagement and retention rates (Litvin *et al.*, 2020; Litvin *et al.*, 2023); Factors such as personalization and adaptivity, and cultural adaptation also have important impacts on intervention effectiveness. Third, user engagement challenges. User attrition is one of the core challenges facing mMHIIs. Research shows that short-term attrition rates (≤ 3 months) are 24.1%, while long-term attrition rates (> 3 months) reach as high as 35.5% (Linardon & Fuller-Tyszkiewicz, 2020). Although strategies such as gamification, personalization, guidance support, and cultural adaptation show some potential in improving engagement, sustained use remains an urgent problem to be solved. Fourth, core functional components. Effective mMHIIs typically integrate multiple functional

modules, including psychoeducation, cognitive restructuring and behavioral activation exercises, mindfulness and relaxation techniques, mood tracking, chatbot support, community interaction, and progress feedback. The scientific combination of these functions is key to ensuring intervention effectiveness. Fifth, research limitations. Existing research has many limitations, including insufficient long-term follow-up, inadequate exploration of mechanisms of action, lack of attention to specific subgroups, weak cultural adaptation research, missing adverse event reporting, and insufficient cost-effectiveness analysis. These issues to some extent limit the full realization of the clinical application value of mMHI.

Comparison with existing literature

The findings of this review are largely consistent with meta-analyses targeting general adult populations (Linardon et al., 2019; Mantani et al., 2017), confirming the general effectiveness of mMHI across different populations. However, this review also reveals several unique characteristics of the college student population: First, generational differences in technology acceptance. As digital natives, college students generally have higher acceptance and proficiency in using mobile applications, which provides favorable conditions for the promotion of mMHI. However, this also means that this group has higher expectations for app quality, user experience, and functional innovation, and poorly designed apps are more likely to be quickly abandoned. This phenomenon is confirmed in the study by Wu et al. (2021). Second, the uniqueness of developmental mental health needs. Depression and anxiety in college students are often closely related to developmental tasks such as academic pressure, interpersonal relationships, identity formation, and career planning. Therefore, interventions tailored to these situational characteristics (such as academic stress management and social skills training) may be more effective than generic interventions. The qualitative study by Salamanca-Sanabria et al. (2023) supports this view. Third, preference for anonymity and autonomy. Due to stigma concerns and pursuit of independence, college students are more inclined toward anonymous, self-help digital interventions (Kählke et al., 2024). However, completely unguided self-help interventions are often unsatisfactory in terms of engagement and effectiveness, suggesting the need to seek a balance between autonomy and support, for example through "on-demand guidance" models.

Future research directions

Combining existing evidence gaps and methodological deficiencies, future research can prioritize the following directions. First, conduct high-quality randomized controlled trials with long-term follow-up. Conduct large-scale, multi-center, long-term follow-up (≥ 12

months) high-quality randomized controlled trials, employing active controls rather than waitlist controls, using intention-to-treat (ITT) analysis and sensitivity analysis to enhance the rigor of causal inference and robustness of results. Second, integrate multi-modal assessment. In addition to self-report scales, integrate objective indicators (such as smartphone sensor data, wearable device physiological indicators, app usage logs, cognitive task performance) to comprehensively evaluate intervention effectiveness and reduce reporting bias. Third, conduct cost-effectiveness and cost-utility studies, performing rigorous cost-benefit analyses to evaluate the economic value of mMHI. Simultaneously explore the scalability, acceptability, and sustainability of mMHI in real-world environments, providing evidence for policy-making and practical applications. Fourth, combine technology with implementation science. Integrate artificial intelligence, machine learning, JITAIs, and multi-modal sensor data with mMHI to develop personalized, contextualized interventions under the premise of acceptable user experience and ethics; simultaneously apply implementation science frameworks, such as Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) and Consolidated Framework for Implementation Research (CFIR) to study feasibility, scalability, and sustainability in real university settings.

Practical recommendations

Based on existing evidence, the following practice-oriented recommendations can be proposed for different stakeholders: First, universities and campus mental health service institutions. Establish a tiered, stepped-care service model, using mMHI as a first-line tool for mild symptoms and preventive needs, employing blended interventions for moderate symptoms, and utilizing mMHI as an auxiliary tool for severe cases and high-risk students. Integrate mainstream evidence-based mMHI into counseling processes, and train counselors to reasonably integrate digital tools in assessment, intervention, and follow-up. Second, app developers and enterprises. Center on evidence-based theories such as CBT and mindfulness, prioritizing the quality of intervention components, and on this basis prudently integrate gamification and narrative elements to enhance engagement. Adopt user-centered and participatory design methods, iteratively optimizing interface and functionality around college students' real-world usage contexts. Advance personalization and adaptive functions (such as JITAIs, AI chatbots), while emphasizing explainability and boundaries of human-machine collaboration. Strengthen data security and privacy protection, and configure crisis intervention channels to ensure clinical safety and ethical compliance. Third, policy makers. Increase public funding for digital mental health services, including

support for the development, validation, and promotion of evidence-based apps, as well as providing free or subsidized app use for low-income students. Raise awareness of mental health issues and acceptance of digital interventions among college students, their parents, and teachers. Meanwhile, promote how to identify reliable mobile mental health resources. Establish quality standards and certification systems for mobile mental health apps, similar to the regulation of pharmaceuticals and medical devices. Standards should cover clinical effectiveness, data security, privacy protection, ethical compliance, and other aspects.

Limitations of this review

This review, while systematically examining the impact of mMHIIs on depression and anxiety in college students, still has several limitations. First, there is heterogeneity in the included literature, including differences in study design, intervention formats, duration, and assessment indicators, which may affect the uniformity and comparability of conclusions. Second, some studies lack long-term follow-up or high-quality randomized controlled designs, limiting judgment on the sustained effects of interventions. Third, the vast majority of evidence originates from Western countries, and cultural adaptation and generalizability remain to be further validated. Additionally, outcome measures primarily based on user self-reports may introduce recall bias. Finally, this review did not conduct rigorous bias risk assessment of the literature, and some results may be affected by publication bias. Future research needs to further validate relevant findings through multi-center, high-quality, cross-cultural studies.

CONCLUSION

This scoping review systematically examined the evidence for mMHIIs in the management of depression and anxiety among college students between 2015–2024. The research indicates that CBT-based and mindfulness-based mMHIIs demonstrate small to moderate efficacy in improving college students' mental health (effect size $d = 0.33-0.68$). Their advantages in terms of convenience, anonymity, and cost-effectiveness align with the characteristics and needs of the college student population, serving as an important complement to traditional services. However, significant gaps remain between evidence and practice. Core challenges include high user attrition rates (24.1% short-term, 35.5% long-term), heterogeneity of intervention effects, unclear long-term maintenance effects, insufficient research on specific subgroups, lack of cultural adaptation validation, and inadequate cost-effectiveness analysis. These factors limit the full realization of the clinical value of mMHIIs.

Future priorities should focus on conducting long-term

randomized controlled trials, deeply exploring intervention mechanisms, developing customized solutions, strengthening cross-cultural validation, systematically evaluating adverse events, and leveraging artificial intelligence to develop intelligent just-in-time adaptive interventions. At the practical level, mMHIIs should be integrated into a stepped-care mental health service ecosystem, where individuals with mild symptoms use self-help apps, those with moderate symptoms adopt blended interventions, and those with severe conditions or high risk use mMHIIs to supplement traditional treatment. This tiered model can optimize resource allocation and enhance service coverage.

Achieving this goal requires multi-stakeholder collaboration: universities integrating digital tools, developers prioritizing evidence-based design, policy makers establishing certification systems, and researchers providing high-quality evidence. Under the premise of ensuring quality, safety, equity, and ethical compliance, mMHIIs have the potential to become an important strategy for addressing the global mental health crisis among college students. The future vision is that every college student in need can conveniently access scientific, safe, and culturally appropriate digital mental health support. Realizing this vision requires continuous research innovation, technological advancement, policy support, and cross-sectoral collaboration. This review provides academia, practitioners, developers, and policy makers with a summary of current evidence and guidance for future action, aiming to jointly promote the scientific application and sustainable development of mMHIIs among the college student population.

DECLARATION

Acknowledgement

None.

Author contributions

Mu JT: Conceptualization, Writing—Original draft preparation, Writing—Reviewing and Editing. Sun P: Supervision, Project administration.

Source of funding

This research received no external funding.

Ethical approval

Not applicable.

Informed consent

Not applicable.

Conflict of interest

Sun P is the Executive Editor-in-Chief of the journal. The article was subject to the journal's standard

procedures, with peer review handled independently of the editor and the affiliated research groups.

Use of large language models, AI and machine learning tools

None declared.

Data availability statement

Not applicable.

REFERENCES

- Amagai, S., Pila, S., Kaat, A. J., Nowinski, C. J., & Gershon, R. C. (2022). Challenges in participant engagement and retention using mobile health apps: Literature review. *Journal of Medical Internet Research*, 24(4), e35120. <https://doi.org/10.2196/35120>
- Arroyo, A. C., & Zawadzki, M. J. (2022). The implementation of behavior change techniques in mHealth apps for sleep: Systematic review. *JMIR mHealth and uHealth*, 10(4), e33527. <https://doi.org/10.2196/33527>
- Bae, H., Shin, H., Ji, H.-G., Kwon, J. S., Kim, H., & Hur, J.-W. (2023). App-based interventions for moderate to severe depression. *JAMA Network Open*, 6(11), e2344120. <https://doi.org/10.1001/jamanetworkopen.2023.44120>
- Balci, S., K uchler, A.-M., Ebert, D. D., & Baumeister, H. (2024). Culturally adapted turkish version of an internet-based mindfulness intervention for university students: A randomized controlled feasibility trial. *BMC Digital Health*, 2(1). <https://doi.org/10.1186/s44247-024-00074-z>
- Bangalan, S., & Agnes, M. C. (2025). A pilot study of the AKBAY mobile app for the mental health of university students. *Journal of Enabling Technologies*, 19(2), 90–101. <https://doi.org/10.1108/jet-11-2024-0075>
- Barati, M., Jormand, H., Moeini, B., Bashirian, S., Keshavarzi, A., Khazaei, S., & Ahmadvand, N. (2025). Can a positive activity intervention based on a mobile application improve well-being? *Journal of Education and Community Health*, 12(2), 110–121. <https://doi.org/10.34172/jech.4732>
- Borjalilu, S. (2023). The efficacy of persian version of mindfulness-based stress management app (aramgar) for college's mindfulness skills and perceived stress. *International Journal of Islamic Educational Psychology*, 4(1). <https://doi.org/10.18196/ijiep.v4i1.16513>
- Bress, J. N., Falk, A., Schier, M. M., Jaywant, A., Moroney, E., Dargis, M., Bennett, S. M., Scult, M. A., Volpp, K. G., Asch, D. A., Balachandran, M., Perlis, R. H., Lee, F. S., & Gunning, F. M. (2024). Efficacy of a mobile app-based intervention for young adults with anxiety disorders: A randomized clinical trial. *JAMA Network Open*, 7(8), e2428372. <https://doi.org/10.1001/jamanetworkopen.2024.28372>
- Castro, O., Mair, J. L., Salamanca-Sanabria, A., Alattas, A., Keller, R., Zheng, S., Jabir, A., Lin, X., Frese, B. F., Lim, C. S., Santhanam, P., Dam, R. M. van, Car, J., Lee, J., Tai, E. S., Fleisch, E., Wangenheim, F. von, Tudor Car, L., M uller-Riemenschneider, F., & Kowatsch, T. (2023). Development of "LvL UP 1.0": A smartphone-based, conversational agent-delivered holistic lifestyle intervention for the prevention of non-communicable diseases and common mental disorders. *Frontiers in Digital Health*, 5. <https://doi.org/10.3389/fdgh.2023.1039171>
- Chan, C. S., Wong, C. Y. F., Yu, B. Y. M., Hui, V. K. Y., Ho, F. Y. Y., & Cuijpers, P. (2021). Treating depression with a smartphone-delivered self-help cognitive behavioral therapy for insomnia: A parallel-group randomized controlled trial. *Psychological Medicine*, 53(5), 1799–1813. <https://doi.org/10.1017/s0033291721003421>
- Conley, C. S., Gonzales, C. H., Huguene, B. M., Rauch, A. A., Kahrilas, I. J., Duffe, J., & Silton, R. L. (2024). Benefits of a technology-delivered mindfulness intervention for psychological distress and positive wellbeing in depressed college students: Post-intervention and follow-up effects from an RCT. *Mindfulness*, 15(7), 1739–1758. <https://doi.org/10.1007/s12671-024-02398-3>
- Dur an, L. D., Almeida, A. M., Figueiredo-Braga, M., & Lopes, A. C. (2023). (uMind) mobile application to support digital literacy interventions in mental health: Development and usability study. In *2023 18th Iberian Conference on Information Systems and Technologies (CISTI)* (pp. 1–6). IEEE. <https://doi.org/10.23919/cisti58278.2023.10211892>
- Ebert, D. D., Zarski, A.-C., Christensen, H., Stikkelbroeck, Y., Cuijpers, P., Berking, M., & Riper, H. (2015). Internet and computer-based cognitive behavioral therapy for anxiety and depression in youth: A meta-analysis of randomized controlled outcome trials. *PLOS ONE*, 10(3), e0119895. <https://doi.org/10.1371/journal.pone.0119895>
- Fuller, C., Marin-Dragu, S., Iyer, R. S., & Meier, S. M. (2025). A mobile app-based gratitude intervention's effect on mental well-being in university students: Randomized controlled trial. *JMIR mHealth and uHealth*, 13, e53850–e53850. <https://doi.org/10.2196/53850>
- Fundoiano-Hershcovitz, Y., Breuer Asher, I., Ritholz, M. D., Feniger, E., Manejwala, O., & Goldstein, P. (2023). Specifying the efficacy of digital therapeutic tools for depression and anxiety: Retrospective, 2-cohort, real-world analysis. *Journal of Medical Internet Research*, 25, e47350. <https://doi.org/10.2196/47350>
- Gaffney, H., Mansell, W., & Tai, S. (2019). Conversational agents in the treatment of mental health problems: Mixed-method systematic review. *JMIR Mental Health*, 6(10), e14166. <https://doi.org/10.2196/14166>
- Gupta, V., Joshi, V., Jain, A., & Garg, I. (2023). Chatbot for mental health support using NLP. *2023 4th International Conference for Emerging Technology (INCET)*, 1–6. <https://doi.org/10.1109/incet57972.2023.10170573>
- Heber, E., Ebert, D. D., Lehr, D., Cuijpers, P., Berking, M., Nobis, S., & Riper, H. (2017). The benefit of web- and computer-based interventions for stress: A systematic review and meta-analysis. *Journal of Medical Internet Research*, 19(2), e32. <https://doi.org/10.2196/jmir.5774>
- Isa, A. K. (2024). Exploring digital therapeutics for mental health: AI-driven innovations in personalized treatment approaches. *World Journal of Advanced Research and Reviews*, 24(3), 2733–2749. <https://doi.org/10.30574/wjarr.2024.24.3.3997>
- Jeong, H., Yoo, J. H., Goh, M., & Song, H. (2024). Deep breathing in your hands: Designing and assessing a DTx mobile app. *Frontiers in Digital Health*, 6. <https://doi.org/10.3389/fdgh.2024.1287340>
- K ahlke, F., Hasking, P., K uchler, A.-M., & Baumeister, H. (2024). Mental health services for german university students: Acceptance of intervention targets and preference for delivery modes. *Frontiers in Digital Health*, 6. <https://doi.org/10.3389/fdgh.2024.1284661>
- Kerr, J. I., Weibel, R. P., Naegelin, M., Ferrario, A., Schinazi, V. R., La Marca, R., Hoelscher, C., Nater, U. M., & Wangenheim, F. von. (2023). The effectiveness and user experience of a biofeedback intervention program for stress management supported by virtual reality and mobile technology: A randomized controlled study. *BMC Digital Health*, 1(1). <https://doi.org/10.1186/s44247-023-00042-z>
- Kersten-van Dijk, E. T., Westerink, J. H. D. M., Beute, F., & IJsselstein, W. A. (2017). Personal informatics, self-insight, and behavior change: A critical review of current literature. *Human-Computer Interaction*, 32(5-6), 268–296. <https://doi.org/10.1080/07370024.2016.1276456>
- Kosasih, F. R., Yee, V. T. S., Toh, S. H. Y., & S undermann, O. (2023). Efficacy of intellect's self-guided anxiety and worry mobile health programme: A randomized controlled trial with an active control and a 2-week follow-up. *PLOS Digital Health*, 2(5), e0000095. <https://doi.org/10.1371/journal.pdig.0000095>
- K uchler, A.-M., Schultchen, D., Dretzler, T., Moshagen, M., Ebert, D. D., & Baumeister, H. (2023). A three-armed randomized controlled trial to evaluate the effectiveness, acceptance, and negative effects of StudiCare mindfulness, an internet- and mobile-based intervention for college students with no and "on demand" guidance. *International Journal of Environmental Research and Public Health*, 20(4), 3208. <https://doi.org/10.3390/ijerph20043208>
- Laure, T., Remmerswaal, D., Konigorski, S., Engels, R., & Boffo, M. (2024). *Optimization of a mobile transdiagnostic emotion regulation intervention for*

- university students: A micro-randomized trial. <https://doi.org/10.31234/osf.io/u967r>
- Lee Yoon Li, M., Lee Si Min, S., & Sündermann, O. (2024). Efficacy of the *mHealth* app intellect in improving subclinical obsessive-compulsive disorder in university students: Randomized controlled trial with a 4-week follow-up. *JMIR mHealth and uHealth*, 12, e63316. <https://doi.org/10.2196/63316>
- Lin, Y., Wu, C., Gau, B., Lin, C., Ho, H., & Lou, M. (2024). Effectiveness study of a cultural adaptation of cognitive-behavioural therapy-based application for depressive symptoms in college students: A randomised controlled trial. *Journal of Psychiatric and Mental Health Nursing*, 32(3), 712–722. <https://doi.org/10.1111/jpm.13146>
- Linardon, J., Cuijpers, P., Carlbring, P., Messer, M., & Fuller-Tyszkiewicz, M. (2019). The efficacy of app-supported smartphone interventions for mental health problems: A meta-analysis of randomized controlled trials. *World Psychiatry*, 18(3), 325–336. <https://doi.org/10.1002/wps.20673>
- Linardon, J., & Fuller-Tyszkiewicz, M. (2020). Attrition and adherence in smartphone-delivered interventions for mental health problems: A systematic and meta-analytic review. *Journal of Consulting and Clinical Psychology*, 88(1), 1–13. <https://doi.org/10.1037/ccp0000459>
- Listiyandini, R. A., Andriani, A., Kusrianti, C., Moulds, M., Mahoney, A., & Newby, J. M. (2023a). Culturally adapting an internet-delivered mindfulness intervention for Indonesian university students experiencing psychological distress: Mixed methods study. *JMIR Formative Research*, 7, e47126. <https://doi.org/10.2196/47126>
- Litvin, S., Saunders, R., Maier, M. A., & Lüttke, S. (2020). Gamification as an approach to improve resilience and reduce attrition in mobile mental health interventions: A randomized controlled trial. *PLoS ONE*, 15(9), e0237220. <https://doi.org/10.1371/journal.pone.0237220>
- Litvin, S., Saunders, R., Jefferies, P., Seely, H., Pössel, P., & Lüttke, S. (2023). The impact of a gamified mobile mental health app (eQuoo) on resilience and mental health in a student population: Large-scale randomized controlled trial. *JMIR Mental Health*, 10, e47285. <https://doi.org/10.2196/47285>
- Lu, S.-C., Xu, M., Wang, M., Hardi, A., Cheng, A. L., Chang, S.-H., & Yen, P.-Y. (2022). Effectiveness and minimum effective dose of app-based mobile health interventions for anxiety and depression symptom reduction: Systematic review and meta-analysis. *JMIR Mental Health*, 9(9), e39454. <https://doi.org/10.2196/39454>
- Lu, Y., Li, Y., Huang, Y., Zhang, X., Wang, J., Wu, L., & Cao, F. (2023). Effects and mechanisms of a web- and mobile-based acceptance and commitment therapy intervention for anxiety and depression symptoms in nurses: Fully decentralized randomized controlled trial. *Journal of Medical Internet Research*, 25, e51549. <https://doi.org/10.2196/51549>
- Luo, Y., Stice, B. L., & Lenz, A. S. (2024). Mental health apps for depression: A meta-analysis. *Journal of Counseling & Development*, 103(1), 25–38. <https://doi.org/10.1002/jcad.12535>
- Ly, K. H., Trüschel, A., Jarl, L., Magnusson, S., Windahl, T., Johansson, R., Carlbring, P., & Andersson, G. (2014). Behavioural activation versus mindfulness-based guided self-help treatment administered through a smartphone application: A randomised controlled trial. *BMJ Open*, 4(1), e003440. <https://doi.org/10.1136/bmjopen-2013-003440>
- Malhotra, S. (2023). Mental health apps: A new field in community mental health care. *Indian Journal of Social Psychiatry*, 39(2), 97–99. https://doi.org/10.4103/ijsp.ijsp_145_23
- Mantani, A., Kato, T., Furukawa, T. A., Horikoshi, M., Imai, H., Hiroe, T., Chino, B., Funayama, T., Yonemoto, N., Zhou, Q., & Kawanishi, N. (2017). Smartphone cognitive behavioral therapy as an adjunct to pharmacotherapy for refractory depression: Randomized controlled trial. *Journal of Medical Internet Research*, 19(11), e373. <https://doi.org/10.2196/jmir.8602>
- Milne-Ives, M., Lam, C., De Cock, C., Van Velthoven, M. H., & Meinert, E. (2019). *Mobile apps for health behavior change in physical activity, diet, drug and alcohol use, and mental health: Systematic review (preprint)*. <https://doi.org/10.2196/preprints.17046>
- Mudau, T., Jithoo, V., & Dietrich, J. (2024). Exploring the demand, practicality, and acceptability of a mental health application intervention for students at a south african university. *South African Journal of Psychology*, 54(2), 171–184. <https://doi.org/10.1177/00812463241249100>
- Nwosu, A., Boardman, S., Husain, M. M., & Doraiswamy, P. M. (2022). Digital therapeutics for mental health: Is attrition the achilles heel? *Frontiers in Psychiatry*, 13. <https://doi.org/10.3389/fpsy.2022.900615>
- Omarov, B., Zhumanov, Z., Gumar, A., & Kuntunova, L. (2023). Artificial intelligence enabled mobile chatbot psychologist using AIML and cognitive behavioral therapy. *International Journal of Advanced Computer Science and Applications*, 14(6). <https://doi.org/10.14569/ijacsa.2023.0140616>
- Reid, S. C., Kauer, S. D., Hearps, S. J., Croke, A. H., Khor, A. S., Sancu, L. A., & Patton, G. C. (2011). A mobile phone application for the assessment and management of youth mental health problems in primary care: A randomised controlled trial. *BMC Family Practice*, 12(1). <https://doi.org/10.1186/1471-2296-12-131>
- Salamanca-Sanabria, A., Jabir, A. I., Lin, X., Alattas, A., Kocaballi, A. B., Lee, J., Kowatsch, T., & Tudor Car, L. (2023). Exploring the perceptions of *mHealth* interventions for the prevention of common mental disorders in university students in singapore: Qualitative study. *Journal of Medical Internet Research*, 25, e44542. <https://doi.org/10.2196/44542>
- Serrano-Ripoll, M. J., Zamanillo-Campos, R., Fiol-DeRoque, M. A., Castro, A., & Ricci-Cabello, I. (2022). Impact of smartphone app-based psychological interventions for reducing depressive symptoms in people with depression: Systematic literature review and meta-analysis of randomized controlled trials. *JMIR mHealth and uHealth*, 10(1), e29621. <https://doi.org/10.2196/29621>
- Sun, S., Lin, D., Goldberg, S., Shen, Z., Chen, P., Qiao, S., Brewer, J., Loucks, E., & Operario, D. (2022). A mindfulness-based mobile health (mHealth) intervention among psychologically distressed university students in quarantine during the COVID-19 pandemic: A randomized controlled trial. *Journal of Counseling Psychology*, 69(2), 157–171. <https://doi.org/10.1037/cou0000568>
- Torous, J., Nicholas, J., Larsen, M. E., Firth, J., & Christensen, H. (2018). Clinical review of user engagement with mental health smartphone apps: Evidence, theory and improvements. *Evidence Based Mental Health*, 21(3), 116–119. <https://doi.org/10.1136/eb-2018-102891>
- Vereschagin, M., Wang, A. Y., Richardson, C. G., Xie, H., Munthali, R. J., Hudec, K. L., Leung, C., Wojcik, K. D., Munro, L., Halli, P., Kessler, R. C., & Vigo, D. V. (2024). Effectiveness of the minder mobile mental health and substance use intervention for university students: Randomized controlled trial. *Journal of Medical Internet Research*, 26, e54287. <https://doi.org/10.2196/54287>
- Wang, P., Chen, H., Li, Z., Xu, W., Chang, Y.-P., & Li, H. (2025). Continuous prediction of user dropout in a mobile mental health intervention program: An exploratory machine learning approach. *Smart Health*, 36, 100565. <https://doi.org/10.1016/j.smhl.2025.100565>
- Weisel, K. K., Fuhrmann, L. M., Berking, M., Baumeister, H., Cuijpers, P., & Ebert, D. D. (2019). Standalone smartphone apps for mental health—a systematic review and meta-analysis. *Npj Digital Medicine*, 2(1). <https://doi.org/10.1038/s41746-019-0188-8>
- Willis, H. A., & Neblett, E. W. (2023). Developing culturally-adapted mobile mental health interventions: A mixed methods approach. *mHealth*, 9, 1–1. <https://doi.org/10.21037/mhealth-22-19>
- Wu, A., Scult, M. A., Barnes, E. D., Betancourt, J. A., Falk, A., & Gunning, F. M. (2021). Smartphone apps for depression and anxiety: A systematic review and meta-analysis of techniques to increase engagement. *Npj Digital Medicine*, 4(1). <https://doi.org/10.1038/s41746-021-00386-8>
- Zainal, N. H., Liu, X., Leong, U., Yan, X., & Chakraborty, B. (2025). Bridging innovation and equity: Advancing public health through just-in-time adaptive interventions. *Annual Review of Public Health*, 46(1), 43–68. <https://doi.org/10.1146/annurev-publhealth-071723-103909>

Zannat, N., & Mahmud, M. (2025). THE DEVELOPMENT OF AN ISLAMIC-INSPIRED DIGITAL THERAPEUTICS APP: EXPLORING MENTAL HEALTH CHALLENGES AMONG

UNIVERSITY STUDENTS. *International Journal of Software Engineering and Computer Systems*, 11(1), 70–91. <https://doi.org/10.15282/ijsecs.11.1.2025.6.0138>