Digital health interventions for depression and anxiety in low- and middle-income countries: A rapid scoping review

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Abstract

Background: Low-and middle-income countries (LMICs), which bear a larger proportion of the global mental illness burden, have been disproportionately impacted by the COVID-19 pandemic due to pre-existing mental health care system deficiencies. The pandemic has also led to a considerable increase in care delivered through digital mental health interventions (DMHIs), many of which have been adapted from in-person formats. There is thus a need to examine their fidelity to the original format, along with issues around usability and other challenges and facilitators to their uptake in LMICs. As most DMHIs have been developed in high-income countries, an examination of their cultural adaptation to LMIC settings will be critical.

Objective: The purpose of this research is to conduct a rapid scoping review of the available evidence for DMHIs for depression and anxiety, two of the most common mental disorders, in LMICs.

Methods: A rapid scoping review was conducted following the PRISMA Extension for Scoping Reviews and processes for rapid reviews by Tricco et al., (2017). PubMed and PsychInfo databases were searched for records published between January 2020, when COVID-19 was declared a public health emergency, and June 2024 using a search strategy developed in consultation with a liaison librarian. The pandemic accelerated the development of DMHIs, and this timeframe was utilized to capture the recent literature that may have incorporated new methods of application. The search strategy was developed across three domains: 1) digital health interventions; 2) depression or anxiety; and 3) LMICs. Data were charted from the final records according to intervention type, and 1) discussions around fidelity, usability, cultural adaptation, and 2) challenges and facilitators to their uptake in LMICs.

Results: A total of 64 records were included in the final analysis, with reasons for exclusion (e.g., focused on mental health in general, not being a DMHI, not focused on LMICs) reported. Six DMHI platforms were identified: 1) mobile app; 2) telemedicine; 3) web-based programs; 4) videoconferencing; 5) virtual reality; and 6) social media-based interventions. Less than half of the included records referenced fidelity, usability, and cultural adaptation, with most of the discussions related to mobile apps. Challenges pertained to the technological system, engagement issues, structural barriers, and concerns around privacy and confidentiality. Facilitators included widespread mobile phone usage, built in supervision and training features, and convenience. Many records emphasized the importance of cultural appropriateness.

Conclusions: Despite the opportunities DMHIs offer for reducing the mental health treatment gap, further work examining fidelity, user engagement, and cultural adaptation is required. Given the rapidly changing landscape of development and delivery of DMHIs, further research is also warranted to capture emergent changes, including the potential for harms in their unrestrained development and ethical implications around the increasing integration of artificial intelligence. Clinical Trial: n/a

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Introduction

Background

Mental illnesses are a leading contributor to the global burden of disease.[1] The COVID-19 pandemic has contributed to further deteriorations in population mental health and exposed critical and persisting gaps in mental health care.[2], [3] The Global Burden of Disease 2020 study estimated the COVID-19 pandemic has led to increases of 28% for major depressive disorders and 26% for anxiety disorders,[4] two of the most common mental disorders.[5] Depression and anxiety disorders are associated with profound disease and socioeconomic burden to the individuals and their relatives.[6] Low-and middle-income countries (LMICs), which bear a larger proportion of the global mental illness burden[7] have been disproportionately impacted due to pre-existing mental health care system deficiencies.[8], [9] Increased mental health issues have in turn placed additional substantial pressures on strained mental health care systems.[2] This is particularly concerning in LMICs, where 75% of people lacked access to mental health care prior to the COVID-19 pandemic (WHO, 2019). Persistent and growing barriers to treatment in LMICs include low mental health awareness, stigma that impacts help-seeking, a shortage and maldistribution of mental health specialists, and care that is concentrated in specialized and tertiary settings with little to non-existing care at the community level.[7], [10]

Globally, the pandemic has also impacted the delivery of mental health care, leading to a considerable increase in care delivered through digital health interventions to address the widespread reduction of in-person care imposed by public health constraints. These include interventions delivered through telephone, videoconferencing, messaging, web-based programs, and smartphone or other mobile device applications (“apps”),[11] collectively referred to herein as digital mental health interventions (DMHIs). Many of these DMHIs target depression or anxiety. For example, there has been a massive increase of smartphone apps since the onset of COVID-19, largely focused on depression and anxiety symptoms.[6], [12] In fact, apps for depression and anxiety are some of the most widely available and downloaded of the health apps.[13], [14] Digital interventions for depression and anxiety can help with health promotion and literacy at the population level; prevention by targeting high-risk individuals or subpopulations; and treatment and preventive services for people with mental health conditions.[15]

Active components of these DMHIs are often based on evidence-based psychological interventions developed for in-person delivery.[16] While it is critical that the interventions are implemented with high fidelity there is limited evidence on which considerations are most relevant and what should be included in guidance for fidelity of digital adaptations from evidence-based in-person formats. There is a need to evaluate if, and how, the theoretical and technical components are applied in the new modus, or can be enhanced by drawing on the unique interactive features of a digital format (e.g., videos, animations).[17] There has also been limited attention to methods for adaptations across contexts to ensure cultural appropriateness for relevance, applicability and, ultimately, effectiveness, [18], [19] particularly for the adaptation of digital interventions.[20] Cultural adaptation can be defined as “the process of systematically modifying an evidence-based intervention to be congruent with the language, values, beliefs, and context corresponding to clients’ cultural backgrounds.”[21]

While DMHIs have been used for two decades, their development and uptake has been greatly accelerated during the COVID-19 pandemic and hold promise as a feasible way to address the growing mental health needs of populations amidst the persistent and growing mental health

treatment gap.[7] This might have been a “black swan” moment described by Wind et al.,[22] acting as a catalyst in the marked shift from in-person mental health care provision to digital health. Challenges that have slowed their implementation in routine care include a lack of acceptance by mental health professionals who may be concerned about threats to the therapeutic alliance, which they believe can only be established in-person.[23], [24] Other challenges include technology and language literacy, data privacy and security concerns, structural issues such as underdveloped technological infrastructure,[7] and poor usability. Usability is the extent to which a product can be used easily, effectively, and with satisfaction to obtain specified goals.[25] Poor usability has been identified as a primary reason for failed adoption.[6] Importantly, there is a need to ensure that all those who need digital mental health care, especially the most vulnerable who experience existing barriers to care, such as those who live in rural and remote areas, with low income, and from culturally diverse communities, have the digital literacy and opportunity to engage with DMHIs to reduce the digital divide.[2]

Rationale and objectives of review

The use of DMHIs for various mental disorders, including depression and anxiety, has been shown to be effective.[2] Others, including mobile apps, have produced mixed results.[26] Some studies have demonstrated their efficacy,[27], [28] effectiveness,[29] and cost-effectiveness,[15], [30], [31] while other studies have reported limited evidence for their effectiveness in reducing symptoms of depression and anxiety.[10], [32], [33] Many DMHIs have been adapted from in-person formats, most commonly developed in high-income countries (HICs), although there is a paucity of evidence on their fidelity to the original format and with limited examination of the cultural adaptation process. Further, although there has been increasing research on DMHIs from LMICs,[34], [35] where over 85% of the global population lives,[36] most DMHIs have been developed and studied in high-income countries,[7], [37] leading to potential biases and limiting generalizability. Knowledge gathered from LMICs will be critical for LMICs. **Thus, the purpose of this research is to conduct a rapid scoping review of the available evidence for digital health interventions for depression and anxiety, the two most common mental disorders, in LMICs.**

The specific objectives of this rapid scoping review are:

1. to identify the types of digital health interventions for depression and anxiety being used and studied in LMICs;
2. to explore their fidelity, usability, and cultural adaptation to a digital format in LMICs; and
3. to examine the challenges and facilitators to their uptake in LMICs.

This scoping review contributes important evidence on the growing adaptation, use of, and barriers to DMHI applications for mental health in the context of the constantly changing landscape of the COVID-19 pandemic and beyond. While some scoping reviews have focused on digital health interventions for mental health in general,[38], [39], [40] and others have incorporated a focus on LMICs,[10] to our knowledge this is the first review that focuses on digital health interventions in LMICs specifically for depression and anxiety, and includes an in-depth review of their fidelity, usability, and cultural adaptation. The effects of the COVID-19 pandemic on mental health care are likely to persist for many years. These consequences will be particularly severe in LMICs, where care prior to the pandemic was already extremely deficient.

Methods

Data sources and search strategy

Considering the need for a timely review, a rapid scoping review was conducted and a protocol was not registered. We used the following definition of a rapid scoping review as proposed by Triccio et al.,[41] “a type of knowledge synthesis in which components of the systematic review process are simplified or omitted to produce information in a short period of time”.[41] Further, scoping reviews seek to provide a broad mapping overview of the extent, range, and nature of the existing evidence base regardless of quality.[42], [43], [44] For these reasons, appraisal of the methodological quality of individual studies was not conducted. A rapid scoping review was conducted following the PRISMA Extension for Scoping Reviews (PRISMA-ScR) and using a search strategy developed in consultation with a liaison librarian at Simon Fraser University. Processes for rapid reviews as outlined by Tricco et al., were followed.[45]

Two databases were searched (PubMed and PsychInfo) following common search methodology for rapid reviews, which advise the search of at least one electronic database (PRISMA standards[46]), with most published rapid reviews utilizing two or more.[45] Pubmed and PsychInfo databases for records published between January 2020, when COVID was declared a public health emergency of international concern by the WHO (declared a pandemic on March 11, 2020) and May 2024, when the search was conducted. The COVID-19 pandemic accelerated the development of DMHIs, and a rapid review with this timeframe was performed to capture the recent literature that may have incorporated new methods of development and application.

The search strategy was developed across the following three domains: (1) digital health interventions, (2) depression or anxiety, and (3) LMICs. While we were interested in articles related to the COVID-19 pandemic, we made the decision to not include COVID-19 as a search domain as we were interested not only in digital health interventions developed to respond specifically to COVID-related anxiety and depression. Instead, the search included the abovementioned three domains, and within the timeframe of the COVID-19 pandemic (2020-2024). A combination of search terms was applied for the automatic search of publications in the above databases, including (“digital” OR “technology” OR “e-health” OR “telemedicine” OR “internet” OR “online”) AND (“depress*” OR “anxi*” OR “mood disorders” OR “anxiety disorders”) AND (“low and middle income countries" OR “developing countries”). Searches included both subject headings and keywords. Search terms for LMICs were taken from the University of Alberta’s Health Science Search Filters resource.[47] See (Appendix 1 and 2) for the full search strategies (PubMed and PsychInfo, respectively). Reference lists of the included studies or relevant reviews were further inspected for additional articles.

Screening strategy and inclusion/exclusion criteria

Records identified in the database search process were screened using title and abstract by one researcher (first author LC). Records were selected for full text review if they reported on: 1) quantitative or qualitative evidence related to DMHIs for depression and anxiety, 2) were from LMICs, 3) were written in the English language, 4) published between January 2020 and May 2024, and) full text was available. In addition to original research articles, other types of articles (e.g., literature reviews, commentaries, case reports) were included if they included depression or anxiety as a primary focus.

We excluded papers that did not include depression or anxiety as a primary focus. Any articles that presented data from multiple countries (e.g., literature review) were included as long as data from LMICs and non-LMICs were disaggregated and reported separately; in these instances only data

related to LMICs were reported. Duplicates were removed across the two databases. Records included for full text review were cross-checked by an additional researcher (senior author JON).

Data extraction and synthesis

Data were extracted from the records that were eligible for full text review and charted into a table according to the following headings: author, year of publication, participant (study location, study population), interventions (platform and techniques, functions), study (design, mental health conditions and outcomes), and discussions around fidelity (either in relation to the original in-person or paper-based format, or ensuring adherence by lay health workers to the intervention protocol), usability (both quantitative and qualitative explorations), cultural adaptation (of DMHIs to the local cultural context), and challenges and facilitators to the intervention(s)' uptake in LMICs.

Results

Article Selection

The initial search of PubMed was conducted in June 2024, and the initial search of PsychInfo was conducted in August 2024. See (Figure 1) PRISMA flowchart for the full study selection process. A total of 836 records were returned and after the removal of 6 duplicates, 830 were included for screening. After performing a title and abstract review, 172 articles were included for full-text review based on our inclusion criteria. A total of 658 articles that did not meet the inclusion criteria were excluded for full-text review. Of the 172 articles included for full-text review, 2 were not retrieved as the full text was not available.

After completing the full-text review of the 170 available articles, a total of 64 records were included in the final analysis. This included 60 original research articles (including 11 protocol papers) along with four literature reviews (one scoping[48] and three systematic[49], [50], [51]). Reasons for exclusion of articles at full-text review that do not meet the inclusion criteria (n=106) were recorded and reported in (Appendix 3). The most common reasons for exclusion included being focused on another topic (e.g., app usage in general), not being a DMHI (e.g., therapists using video or telephone to deliver regular counseling without an accompanying app) results from reviews (global-focused) being combined without data from LMICs reported separately, focused on mental health in general, and not describing the use of a DMHI. A quality appraisal was not conducted considering the nature of this rapid scoping review, which did not focus on an examination of the effectiveness of the DMHIs, along with the emergent nature of the literature.

(Table 1) provides an extracted summary of the included studies, including participant characteristics (location, population), intervention characteristics (platform, techniques and functions) and study characterictics (design, mental health outcomes). Additional extracted information on fidelity, usability, cultural adapation, and challenges and facilitators to their uptake in LMICs are provided in (Table 2).

Table 1: Summary of the included articles (participant characteristics, intervention characteristics, and study characteristics)

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
Aalaei et al. (2021)	Iran	Hospitalized COVID-19 positive patients at Imam Reza Hospital in Mashhad (n=112)	Mobile phone app	Mobile-based psychological counseling and health status monitoring	PROTOCOL: RCT: two parallel groups	Depression, anxiety
Abbasalizadeh et al. (2024)	Iran	ICU nurses from two Tehran hospitals (n=60)	Android smartphone app	Resilience training, developed based on the micro-learning educational method	RCT: single-blinded	Anxiety, stress. Significant reductions in stress, from 10.77 ± 3.33 to 9.00 ± 1.66 (P = 0.001), and in anxiety, from 9.43 ± 3.35 to 7.93 ± 0.98 (P < 0.001).
Abi et al. (2024)	Lebanon	Participants from 2 previous RCTs that demonstrated effectiveness of the intervention, staff members, and external stakeholders	Digital intervention (Step-by-Step [SbS]), delivered through an app or a website	Guided self-help intervention	Qualitative study involving key informant interviews	Depression. High level of acceptability of SbS among Lebanese and Syrians and identified sub-groups for whom acceptance might be lower (e.g., older adults).
Akbari et al. (2022)	Iran	Home-isolated COVID-19 patients visiting Hamadan Sina Hospital (n=60)	Whatsapp messages and instructional videos	Virtual training of relaxation techniques via Whatsapp messages and instructional videos in the form of 8 educational messages	RCT: two-group parallel	Anxiety. Relaxation techniques are effective in reducing anxiety among COVID-19 patients.

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
Alavi et al. (2020)	Iran	General population with Generalized Anxiety Disorder (GAD) diagnosis by psychiatrist (n=152)	Computer-based intervention delivered via email	12 weekly e-CBT intervention modules and homework assignments are presented through Microsoft PowerPoint and delivered via email. Content is delivered with structured support from trained clinicians	RCT	GAD
AlQarni et al. (2023)	Saudi Arabia	Frontline healthcare providers from Imam Abdulrahman Bin Faisal University and King Fahad Hospital (n=147)	e-Health intervention delivered via a website	MP3 recordings and electronic questionnaires are delivered via a website. Daily 20 minute mindfulness sessions took place over a 2-week period.	RCT: triple-blinded (1:1)	Anxiety. Significant improvement in the psychological well-being and reduction of the state anxiety of the 2 groups, but not in the trait anxiety.
Amer et al. (2023)	Egypt	Adults ≥ 18 years from Mansoura University's Faculty of Computers and Information (n=5)	Mobile app (Sokoon)	Gamified CBT app focused on 7 intervention skills: 1) relaxation; 2) gratitude; 3) self-compassion; 4) problem-solving; 5) social skills; 6) behaviour activation; 7) cognitive restructuring	Pilot study	Depression, anxiety. Anxiety symptoms decreased from the pretest (M = 10, SD =.7) to the posttest (M = 4.2, SD = 1.5), and depressive symptoms from (M = 10, SD = 2.05) to posttest posttest (M = 6, SD = 1.7).
Amer et al. (2024)	Egypt	Adults ≥ 18 years from Mansoura University's Faculty of Computers and Information (n=30)	Mobile app (Sokoon)	CBT app that incorporates techniques such as Hexad theory, gamification, and dynamic difficulty adjustment	Single-group pre-post design	Depression, anxiety. Positive impact on reducing symptoms of depression and anxiety.

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
Araya et al. (2021)	Brazil	Patients with depressive symptoms, with comorbid hypertensin or diabetes (n=880 in Brazil; n=432 in Peru)	Smartphone intervention	18-session, low-intensity digital intervention delivered over 6 weeks via a provided smartphone. Based on behavioural activation and supported by nurse assistants	Two RCTs; 1 cluster-randomized in Brazil and 1 individual-level randomized in Peru	Depression. Significantly improved depression symptoms at 3 months; effect size small in Brazil and effects were not sustained at 6 months.
Atif et al. (2022)	Pakistan	Women living in resource-poor rural communities (n=3) and peer delivery agents (n=3)	Tablet or smartphone-based app (Thinking Healthy Programme)	CBT intervention delivered by a virtual avatar therapist that is operated by a lay peer (woman from the neighbourhood). Peer and the avatar act as co-therapists	Usability testing study	Depression (perinatal)
Bhat et al. (2023)	India	Women in self-help groups	Tablet app (MITHRA)	Multiuser Interactive Health Response Application (MITHRA) for depression screening (PHQ9) and brief intervention (HAP modules). App will include a dashboard for the study team to access participant summary data and provide alerts	PROTOCOL: Focus groups	Depression
Byanjankar et al. (2021)	Nepal	Lay counselors caring for adolescent mothers with depression	Platform (StandStrong), comprising the StandStrong Counselor mobile app, and a cloud-based processing	App visualizes passively collected GPS, proximity, and activity data. Lay counselors use the app during counseling sessions to discuss mothers' behavioural patterns and clinical progress over the	App development paper	Depression (maternal)

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
			system	5-week intervention (Healthy Activity Program)		
Chau et al. (2024)	Vietnam	Adults ≥ 18 years in community-based settings	Smartphone app (VMood)	Supported self-management based on CBT principles with supportive coaching from a social worker delivered by chat via app	PROTOCOL RCT: stepped-wedge	Depression, anxiety.
Cuijpers et al. (2022)	Lebanon	People with depression residing in Lebanon (n=680)	Internet-connected device (Step-by-Step [SbS]	5-session intervention designed to treat depression. Provides psychoeducation and training in behavioural activation through an illustrated narrative, with additional therapeutic techniques such as stress management and relapse prevention. Delivered with guidance from nonspecialist helpers.	RCT: single-blind, two-arm pragmatic	Depression. ITT analyses showed significant treatment effects for both primary outcomes, depression (moderate)and functional impairment (moderate) and significant effects on anxiety.
Cuijpers et al. (2022)	Lebanon	Syrian refugees living in Lebanon (n=569)	Internet-connected device (Step-by-Step [SbS]	5-session intervention designed to treat depression. Provides psychoeducation and training in behavioural activation through an illustrated narrative, with additional therapeutic techniques such as stress management and relapse prevention. Delivered with guidance from	RCT: single-blind, two-arm pragmatic	Depression. Outcomes showed that it is feasible to conduct a large-scale RCT and lent support to the feasibility and acceptability of Inuka, including evidence of preliminary effectiveness.

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
				nonspecialist helpers.		
Dambi et al. (2022)	Zimbabwe	General population (n=176)	Digital app, delivered via web or mobile app (Inuka)	A chat-based digital app developed from the Friendship Bench problem-solving therapy intervention. Participants received 6 problem-solving therapy sessions delivered by lay counselors who are primarily community volunteers	Feasibility study: pragmatic quasi-experimental design	Common mental disorders (CMDs) including depression, anxiety
Dosani et al. (2020)	LMICs	Women	Various	Various	Scoping review	Depression (perinatal). 12 articles met the inclusion criteria. Results revealed that minimal literature is currently available on the use of mobile health for perinatal depression in low- and middle-income countries.
Fu et al. (2020)	LMICs	Various	mHealth	Various	Systematic review and meta analysis	22 studies were included. Findings showed that digital psychological interventions, which have been mostly studied with depression and substance misuse, are superior to control conditions, including usual care, and are moderately effective in LMICs.

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
Ghanbari et al (2021)	Iran	Women with nonmetastic breast cancer aged 20 to 60 years (n=82)	Smartphone app (BCSzone) and online support group	Guided self-management psychoeducational intervention, delivered through BCSzone, along with nurse-assisted online mobile support sessions delivered through WhatsApp, over a total of 4 weeks	RCT: unblinded	Anxiety. Statistically significant differences between the mobile psychoeducation group and controls (P<.001). The paired t test for mean scores of anxiety showed significant reductions in the scores of anxiety.
Gonsalves et al. (2020)	India	Secondary school students (n=11)	Smartphone app (POD Adventures)	Gamified problem-solving intervention supported by non-specialist couselors via phone.	Parallel, two-arm, individually-randomized pilot controlled trial	Depression, anxiety. No intervention arm participants completed the intervention because participants could not be reached.
Green et al. (2020)	Kenya	Pregnant women and new mothers recruited from public hospitals (n=41)	Tablet or smartphone app (Healthy Moms)	Task-sharing thinking healthy program adapted for automated delivery via a mobile phone or tablet; uses an existing AI system called Tess (Zuri in Kenya) to driver conversations with users	Pre-pilot study; single-case experimental design	Depression (perinatal). Authors estimated that using the alpha version of the app may have led to a 7% improvement in mood.
Iravani et al. (2023)	Iran	Pregnant women from health centers (n=104)	Tele-medicine	Counseling services delivered by researcher through telephone conversations, text messages, and applications such as WhatsApp, Telegram, and Instagram, over a 2-month period. Educational video clips	Quasi-experimental study	Anxiety. Health anxiety scores of pregnant women in the control group were significantly higher than those of the experimental group. Also, the mean (SD) scores of pregnancy-related anxiety in the

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
				were provided to the participants in 8 sessions through a mobile app.		control group were significantly higher compared with the intervention group
Jannati et al. (2020)	Iran	Women ≥ 18 years who attended health care centers in Kerman, Iran (n=75)	Mobile phone app (Happy Mom)	CBT app consisting of 8 lessons conducted over 8 weeks. Participants follow the story of women who suffered from post-partum depression and learn how they manage their symptoms, which they can apply to their own lives	Non-blinded parallel-group randomized controlled trial	Depression (post-partum). Intervention group: average Edinburg Post-natal Depression Scale score after intervention was 8.18 and in the control group was 15.05, which was statistically significantly different ($p < 0.001$)
Kanuri et al. (2020)	India	College students	Online intervention (Mana Maali Digital Anxiety Program)	Culturally and digitally adapted evidence-based CBT intervention delivered over 20 sessions for students to: 1) learn about anxiety; 2) identify symptoms; 3) monitor thoughts and feelings; and 4) cope with their anxiety.	Initial usability, acceptability and feasibility examination	GAD. Results indicated high usability, with the average rating ranking in the top 10% of general usability scores. Participants offered changes to improve usability and perceived acceptability among peers struggling with mental health issues.
Kim et al. (2023)	LMICs	General population	Digital mental health tools	Various	Systematic review and meta analysis	Depression, anxiety. 80 studies included in the meta-analysis and 96 studies included in the systematic review. Digital mental health tools are moderately to highly effective in

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
						reducing depression and anxiety symptoms in LMICs.
Kola et al. (2022)	Nigeria	Adolescent mothers (n=17) and maternal health care providers with experience in perinatal depression (n=25) who were participants of a previous clinical trial called EXPONATE	Mobile-phone intervention	Design of a theory-informed psychological intervention for adolescent perinatal depression, based on an intervention (EXPONATE) that incorporated the treatment specifications of the WHO mhGAP-IG. 4 components: parenting skills training, problem solving, psychoeducation, and use of available social support.	Focus groups	Depression (perinatal). FGD showed that 70% of the barriers identified related to the inner setting and the characteristics of individuals in the intervention (e.g., clinicians knowledge deficit on care of young mothers with depression, lack of interest in motherhood).
Kusumadewi et al. (2023)	Indonesia	Medical students from Gadjah Mada University Yogyakarta (n=66)	Smartphone app	App using asynchronous digital cognitive education, divided into 3 parts, including information, therapy (based on Beckian Cognitive Therapy), and daily journal sections.	RCT: non-blinded	Anxiety. Significant effect on reducing anxiety scores from the 2nd week to the 8th week.
Lahti et al. (2020)	South Africa and Zambia	Higher education institute academics and PHC practitioners in 3 provinces in South Africa and 2 provinces in Zambia	Mobile app	Screening tool to be used in PHC settings	PROTOCOL: Mixed-methods multi-site design	Depression
Liem et al. (2020)	Macao	Overseas Filipino workers (OFWs) in Macao (Special Administrative Region)	Internet-connected device (Step-by-Step [SbS]	Culturally adapted Filipino version of the WHO SbS program. 5-session intervention for depression	PROTOCOL: Pilot RCT	Depression, anxiety. The primary outcome (depression) and psychological secondary

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
				that provides psychoeducation and training in BA, with additional therapeutic techniques such as stress management and relapse prevention. Delivered with guidance from nonspecialist e-helpers (e.g., CHWs, students)		outcomes (anxiety symptoms and wellbeing) will be measured using validated instruments.
Logie et al. (2022)	Uganda	Urban refugee and displaced youth aged 16-24	Virtual reality (VR) and group problem management plus (GPM+)	VR only arm: immersive, interactive 15-minute VR session that integrates mental health literacy, psychological first aid, and mindful self-compassion. VR and GPM+ intervention: VR intervention and GPM+, (WHO brief psychological intervention) delivered over 5 group sessions by peer navigators for stress management, problem-solving, BA, and social support. Additional support includes weekly SMS messages with mental health literacy information and bidirectional check-ins.	PROTOCOL: 3-arm cluster RCT	Depression.
Luitel et al. (2023).	Nepal	Primary healthcare workers trained in using the WHO mhGAP mobile application in Jhapa	Smartphone app (WHO e-version of the mhGAP program)	WHO launched the e-version of the mhGAP in 2017. 8 modules to address key priority mental health	Qualitative	Mental health, including depression. HCWs found the app helpful to verify and

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
		(n=15)		conditions including depression		confirm their assessment and diagnosis.
Maharjan et al. (2021).	Nepal	Depressed (n=11) and non-depressed (n=27) adolescent and young mothers	Smartphone app (StandStrong)	Through 1) smartphone app and 2) Bluetooth beacon, sensing data are passively collected on mothers' geographic movement, physical activity, audio environment, and mother-infant proximity	Feasibility study	Depression
Mazhari et al. (2022)	Iran	Inpaients with COVID-19 at Afzalipour Hospital (n=200)	Web-based eHealth intervention	A questionnaire (sociodemographic questions and II HADS questionnaire - Hospital Anxiety and Depression Scale) was administered to the participants via WhatsApp. After 2 days, the psychiatric resident video called those who completed the Questionnaire to assess depression (Hamilton Depression Rating Scale) and anxiety (Anxiety Rating Scale)	Cross-sectional descriptive study	Depression, anxiety. This study examined the agreement between online self-assessment and psychiatric telephone interview among COVID-19 survivors for depression and anxiety. Agreement between online self-assessment and telephone interview was not significant.
Moulaei et al. (2023)	Iran	Patients with depression and anxiety disorders from Kerman University of Medical Sciences	Mobile app	Self-management of depression and anxiety disorders	App development paper	Depression, anxiety
Mukherjee et al.	India	Adolescents living in 60	Mobile app	Two components: 1) anti-	App	Depression, anxiety

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
(2024)		slum clusters spread across New Delhi and Vijayawada in		stigma campaign and 2) mobile-based self-care app	development paper	
Muniswamy et al. (2022)	India	Remotely working software professionals working in IT firms who are low in physical and mental health (n=160)	Social media (Facebook) based fitness intervention (FIIT)	Modules provided via weekly Facebook messages focused on factors affecting sedentary behaviour and mental health, such as recognizing symptoms of depression, stress, and anxiety, and physical activity modelling, delivered over 8 weeks. Personal telehealth consultations delivered by experts via chatbox.	RCT: two-phase pragmatic	Anxiety, depression. Significant difference in the scores of stress and anxiety within and between the groups, but only within for depression.
Nabunya et al. (2024)	Uganda	Youths aged 14-17, HIV-positive, and receiving care and Antiretroviral therapy (ART) from one of the participating clinics, and living within a family	Mobile intervention (Suubi-MHealth)	Educational content incorporates recommendations for CBT for ART adherence and depression as applied to HIV medication adherence. Content is broken down into 20 modules.	PROTOCOL: Pilot RCT	Depression
Najafi et al. (2023)	Iran	Females with relapsing remitting multiple sclerosis (RRMS) recruited through the local MS association (n=45)	Online visual platforms: Google Meet, Zoom, Instagram	Online supervised interventions/sessions for tele-yoga and tele-Pilates delivered 3 times a week, over 8 weeks. Each session included 3 phases: warm up, main poses, and cooldown. Certified instructors provided	RCT: single-blind	Depression. Significant improvements were observed in depression (p = 0.001).

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
				supervision.		
Najafi et al. (2023)	Iran	82 people with either relapsing remitting multiple sclerosis (RRMS) or secondary progressive MS (SPMS) from the Shiraz University of Medical Sciences (m=82)	Tele-Pilates and tele-yoga training	Online supervised interventions/sessions for tele-yoga and tele-Pilates delivered 3 times a week, over 8 weeks. Each session included 3 phases: warm up, main poses, and cooldown. Certified instructors provided supervision.	RCT	Depression. Significant time × group interactions were observed for mental health ($p = 0.05$), and a decline in depression ($p = 0.002$). Post-hoc analysis showed depression improvements for both interventions, but were not statistically significant ($p > 0.05$).
Njoroge et al. (2023)	Kenya	Healthcare workers from 5 healthcare facilities	Mobile app	Weighted sensor stream signatures that predict near-term risk of a major depressive episode and future mood. Deployment of a mobile app platform and use of novel analytic approaches (Artificial Intelligence and Machine Learning)	Feasibility study	Depression
Nurbaeti et al. (2021)	Indonesia	Convenience sample of postpartum mothers	Smartphone app (IMSD)	Initiative Maternal Screening Depression (IMSD) app seeks to detect PPD symptoms early. Asks a mother to provide their information (picture, health personnel, demographics, current obstetric condition, and current baby's condition)	App development and RCT	Depression (PPD)

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
Nwaogu et al. (2021)	Nigeria	Construction personnel: site supervisors and project managers based on a log collected from the Nigerian Institute of Building (n=62)	DMIHs (various)	Various	Open-ended survey: qualitative technique	Anxiety, depression. DMHIs used by respondents included mobile-based apps (14/24, 58%) and web-based apps (10/24, 42%), for stress, depression, anxiety management, and mental fitness.
Ofoegbu et al. (2020)	Nigeria	Educational technology students of Nigerian universities identified as having depression (n=192)	Internet-delivered intervention (GIAI)	Initial support session via telephone and regular guidance from the therapists (clinical staff of the federal universities) via telephone and the internet, over 10 weeks. Covers interactive peer support, cognitive disputation, behavioural homework assignments, psychoeducation, role-play, and depression management.	Group-randomized trial	Depression. Significant reduction in depression among students in the treatment group when compared to those in the usual-care control group.
Pasyar et al. (2023)	Iran	Systemic Lupus Erythematosus patients referred to Hafez clinic affiliated to Shiraz University of Medical sciences (n=124)	Smartphone-based supportive counselling	Daily supportive counselling using text and multimedia messages for 8 weeks, delivered via a WhatsApp channel, according to the topic's axes. Feedback and questions can be sent to research team members.	RCT: pretest-posttest	Anxiety (health). The level of health anxiety (MD=11.34, P < 0.001) of the experiment group was significantly lower than the control group.

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
Patel et al. (2021)	Fiji Islands	Community health nurses (CHNs) (n=48)	mHealth app (ASRaDA)	Guidelines from the Center for Epidemiological Studies Depression Scale (CES-D) and the Suicide Behaviors Questionnaire – Revised (SBQ-R) for suicide were programmed into ASRaDA and given in online supplemental appendices	Experimental design	Depression. CHNs took less time to process patient information with more accurate diagnostic and therapeutic decisions compared with paper-based or no guideline conditions. A change in reasoning pattern for nurses' information processing was observed.
Pozuelo et al. (2023)	South Africa and Uganda	Adolescents in rural South Africa and Uganda (n=160)	Smartphone app (Kuamsha)	Delivers behavioural activation (BA) using storytelling techniques and game design elements. Each story consists of 6 modules (“episodes”) played in sequential order, with each covering different BA skills. Includes support via phone calls.	App development paper: iterative user-centered agile design	Depression
Putri et al. (2022)	Indonesia	Participants who used 8 of the most popular Android mHealth platforms	mHealth platforms	Teleconsultation focus	Mysterious shopping approach	Depression
Ramnath et al. (2021)	India	General population for both COVID-19 and non-COVID-19 infected patients	Smartphone app	N/A (online survey explored the needs of individuals with depression in India and a systematic evaluation of depression apps currently available investigated user needs)	Online survey + systematic evaluation	Depression

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
Roshid et al. (2024)	Bangladesh	Informal female caregivers of cancer patients in Bangladesh	mHealth psychoeducation and Benson relaxation technique (BRT)	Uses self-determination theory (SDT) and the BRT for symptom management, maintaining and enhancing relationships, problem-solving, stress and coping, self-care, and effective communication. Includes 6 sessions over 6 months, where recorded videos will be provided face-to-face or via a digital device.	PROTOCOL: RCT: prospective, open-label, two-arm (1:1)	Anxiety, depression
Sarpourian et al. (2022)	Iran	Students at the undergraduate, postgraduate, and PhD levels from the Kerman University of Medical Sciences and Shiraz University of Medical Sciences (n=30)	VR and counseling therapy	Participants observed 4 virtual classroom scenarios in a 30-min session, which included a virtual classroom and comprised 4 parts	Quasi-experimental study	Anxiety (public speaking). VR and counseling did not affect students' SA (social anxiety), but they reduced PSA (public speaking anxiety).
Seddigh et al. (2023)	Iran	Adolescent girls with type 1 diabetes who had a clinical record at Shiraz's Imam Reza (AS) Clinic of Diabetes (n=62)	Yoga therapy via virtual training	Eight 60-minute sessions (1 online and 7 offline) of yogic practices, held for 8 consecutive weeks. The online session (1st session) was held through Adobe Connect Reader for 90 min. Before each session, a virtual training session on performing the Asana exercises was presented		Depression. The mean of the depression total score was significantly lower in the experimental arm at the trial end. Also, the reduction in mean change from the baseline to the trial end was significantly more in the experimental arm.
Shalma et al.	Indonesia	Adolescents	Mobile app	Key features of the	Mixed methods	Depression

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
(2023)				mHealth app include a mood tracker, activity target, and medication, along with supporting features that complement the design including education articles and early detection features	to design an mHealth intervention	
Shaygan et al. (2023)	Iran	COVID-19 patients in home quarantine (n=72)	Telephone intervention	videos, audio files, and educational texts regarding mental health, coping strategies, positive thinking, hope, and spiritual well-being, and some enjoyable activities such as relaxation music. Other psychological interventions included encouraging the patients to apply the psychological techniques, share their good memories, thank God, and express their positive abilities in a variety of areas in the group. These interventions were provided daily for 14 days.		Anxiety. State-trait anxiety was significantly lower in the participants who underwent interactive psycho-educational interventions - the mean score of state anxiety was mean(SD) 34.69 (10.75) in the intervention group and mean(SD) 45.75 (13.01) in the control group after the intervention. Based on the partial Eta squared (η2) that was equal to 0.19, a large effect size was reported.
Singla et al. (2024)	India	Embedded in 3 programs to scale up the Healthy Activity Program (HAP). Includes participants from those programs.	Smartphone app (PEERS)	PEERS app aims to facilitate remote registering and scheduling patients, collecting patient outcomes, rating therapy quality and assessing	Mixed methods	Depression

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
				supervision quality among frontline treatment providers delivering BA for depression.		
Sinha et al. (2023)	United Kingdom, United States, and India	General population	Digital mental health app (Wysa)	Wysa is an Ai-enabled, chat-based app aimed at building resilience by fostering positive self-view and self-reflection. Includes a conversational agent and various evidence-based intervention-based tools and techniques, such as CBT and mindfulness	Retrospective observational design	Depression, anxiety
Soltani et al. (2024)	Iran	Patients with MDD referred to Razi Hospital and the Psychiatry Clinic of Madani Hospital (n=64)	Smartphone app (Yara)	Includes a section with 3 tests for the daily report of patients' sleep quality, suicidal thoughts, and anxiety. Content includes a daily exercise video to increase physical activity, morning meditation exercise, yoga video for bedtime. The client receives motivational sentences daily and records their daily activities.	RCT: pretest-posttest design	Depression and associated symptoms
Taylor Salisbury et al. (2021)	Nepal and Nigeria	Primary care workers and patients from ~20 primary health clinics (PHCs) in Nepal and 6 PHCs in Nigeria	Mobile app (WHO updated electronic Mental Health Gap Action	For diagnosis and management of depression. The app features a reference mode for training and a patient mode for	Feasibility study	Depression

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
			Programme Intervention Guide [e-mhGAP-IG])	assessments. Health workers can access possible conditions through the Master Chart and then select modules for further assessment. All information is accessible in a clinical dashboard that can help supervisors identify any issues that can be addressed in supervision		
Than et al. (2023)	Vietnam	Family caregivers of people with dementia living in the community who attend the Department of Geriatrics at Gia Dinh People's Hospital	Smartphone app	App will be designed by participants and include weekly online psycho-educational group sessions hosted on the Zalo app. Caregivers will be added to a "Caregiver Support Group" room in Zalo. Weekly, the administrator will post one topic for discussion.	PROTOCOL: Pilot RCT	Depression, anxiety
Torrey et al. (2020)	Columbia	Patients from 2 primary care clinics, 1 urban and 1 rural in a small town (n=2656 screened)	Technology-supported care	Includes waiting room kiosks to screen primary care patients, decision support tablets to guide doctors in diagnosis and treatment, and access to digital therapeutics as a treatment option.	Descriptive study	Depression. Primary care doctors increased the percentage of patients diagnosed as having depression and alcohol use disorder from next to 0% to 17% and 2%, respectively.
Van der Watt et al. (2020)	Chile, Denmark, South	Various	Various	Remote mood monitoring that includes distant support in participants with	Systematic review	Depression. Distant mood monitoring was effective in

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
	Africa, and the US			mood disorders.		improving depression scores but not mania scores. Feasibility varied.
Vera Cruz Dos Santos et al. (2021)	Brazil and Peru	Patients of public health care services for hypertension, diabetes, or both conditions in São Paulo, Brazil (n=880) and Lima, Peru (n=442)	Smartphone app (CONEMO)	Low-intensity mHealth intervention based on BA principles aimed at reducing symptoms of depression, with minimal support by a nurse or nurse assistant (with weekly supervision from a psychiatrist). Includes 18 brief, automated mini-sessions delivered over a 6-week period.	PROTOCOL: Economic evaluation alongside two RCTs	Depression
Weierstall et al. (2021)	Burundi	Burundian AMISOM (African Union Mission to Somalia; UN-approved mission) soldiers (n=463)	Tablet app	Structured clinical interviews (in-person) for assessments of clinical symptom profiles by rating symptoms and responses in field research (diagnostic procedure) via tablet computers.	Feasibility study	Depression. Findings demonstrated that tablet-supported assessments can provide a useful application of mobile technology in large-scale studies, especially in resource-poor settings.
Zamanifard et al. (2022)	Iran	Children with type 1 diabetes aged 8-12 years who were referred to Imam Reza Clinic of Diabetes in Shiraz (n=40)	Virtual painting therapy	Six 2-hour group therapy sessions delivered once a week for 6 weeks via WhatsApp video call by the main researcher (painter and trained by the assistant psychologist). Children were encouraged to draw anything and those	RCT	Depression, anxiety. Significant difference between the groups regarding anxiety (P=0.02) and depression (P<0.001); however, the difference in self-efficacy was not significant (P=0.20).

Author (year)	Participant		Intervention		Study	
	Location	Population (n, where applicable)	Platform (name, if applicable)	Techniques and functions	Design	Mental health
				who showed anxiety and depression in their paintings were identified and reports sent to their parents for follow-ups.		
Zuccolo et al. (2021)	Brazil	Pregnant women aged between 16-40 years with depression	Smartphone app (Motherly)	Based on three concepts to deliver BA: psychoeducation, behavior monitoring, and gaming elements. Package of interventions composed of various modules, such as mental health, sleep, prenatal/ postnatal support. Includes 4 online sessions of brief CBT in 8 weeks.	PROTOCOL: RCT: 2-arm	Depression (in pregnant women)

Table 2: Summary of fidelity, usability, cultural adaptation, and challenges and facilitators by types of interventions

Intervention platform and techniques (n)	Fidelity	Usability	Cultural Adaptation	Challenges	Facilitators
Summary (total articles = 64)	14 articles reported on fidelity.	25 articles reported on usability.	27 articles reported on cultural adaptation.	17 articles reported on challenges to uptake of DMHIs in LMICs.	15 articles reported on facilitators to uptake of DMHIs in LMICs.
Mobile app (n=36)	**10 articles reported on fidelity:** - seven studies reported the process for assessing fidelity (e.g., fidelity checklist, PRISM framework) - one study mentioned that the delivery format (app-with automated features) itself ensures that key intervention ingredients are delivered to fidelity and at the right dose - one study indicated the intervention was developed with the original intervention structures in place - one study indicated that the intervention itself (for detection and treatment) can help with consistency in diagnosis and treatment	**19 articles reported on usability:** - six studies mentioned the use of a survey/measure to capture usability (e.g., System Usability Scale; usability metrics from Nielsen Norman Group) - five studies were focused on usability/ feasibility testing, with two reporting high usability - two protocol papers described how app development will follow a user-centred iterative design - five studies stated the intervention had demonstrated usability - a qualitative study reported health care workers found the mobile app helpful for verifying and confirming their diagnoses	**20 articles reported on cultural adaptation:** - one study described a narrative approach involving local women - one study mentioned a participatory approach - 11 studies discussed importance of identifying what would be culturally acceptable - one article mentioned the identification of measures that had been validated in the implementation country, or worked closely with local partners to adapt measures to enhance cultural validity - one study mentioned the use of a guide adapted for the health system of the implementation country - one study noted that adaptation of the intervention into the local language would be a priority target for development - one paper described how	**10 articles reported on challenges:** - one study mentioned system lags - one study reported sustained engagement of individuals who are depressed, illiteracy, accessibility of mobile phones, resource constraints for training - one study reported the challenge of a practice gap between healthcare professionals and application developers - one study mentioned challenges of online study and delivery method where participants complete task in their own time, accessibility of mobile phones, and lack of sensitization to formal mental health interventions - one study mentioned damaged or lost phones and high churn (drop-out) - a qualitative study mentioned patient flow,	**10 articles reported on facilitators:** - one study indicated widespread mobile phone usage as a facilitator - one study mentioned built-in supervision and training features support scale-up - a protocol paper mentioned convenience and integration into existing social and health care systems will support scalability - one study indicated interventions being delivered in structured settings, such as schools, web-based delivery rather than app-based as they do not require regular updating, and distinct adaptations that account for population-specific needs - one RCT mentioned convenience - one study mentioned orientation programs, mobilization of community health volunteers, and including mental health in

Intervention platform and techniques (n)	Fidelity	Usability	Cultural Adaptation	Challenges	Facilitators
			the intervention will be led by a local partner to ensure its cultural appropriateness - a qualitative study mentioned the intervention has been translated, adapted, and evaluated - one study reported the back-and-forth translation of questionnaires - one study only mentioned that the app was designed for the specific population	technological literacy, poor internet connection, and distrust in apps - one study reported data limits, battery charging issues, burden of carrying phones, lack of family involvement, lack of electricity, and privacy and confidentiality - one study reported increased screen time, network and connectivity issues, app navigation, app related challenges (e.g., bugs), accessibility of mobile phones - one study reported internet connectivity - one study reported internet connectivity, lack of visual cues and treatment adherence	the school curriculum - one study reported facilitators of an understanding of the intervention and its potential benefits - one study mentioned tailored interventions that are relatable - one study reported buy-in from providers and clinical experts and demonstrated clinical utility - one study mentioned efficiency of using tablets
Telemedicine (n=4)	--	--	--	--	--
Web-based programs (n=6)	One study reported on fidelity, indicating fidelity checks were important for quality assurance and performance improvement	Two studies reported on usability: - One study showed that poor usability was a major barrier to adherence of both users and e-helpers; straightforward techniques seemed to be more accepted than complex; appealing design, features,	Two studies (the same 2 that reported on usability) indicated extensive cultural adaptation was conducted, resulting in the intervention having high cultural relevance and acceptability	Three studies reported on challenges: - One study reported forgetting login credentials, time constraints, intervention bugginess, and retention of lay health workers - One study reported technological proficiency, - One study reported challenges of stigma and	Two studies reported on facilitators: - One reported improved access to mental health care, especially for those who are tech-savvy, literate, and have access to devices - One study reported a facilitator as the intervention being culturally appropriate

Intervention platform and techniques (n)	Fidelity	Usability	Cultural Adaptation	Challenges	Facilitators
		colours, and easy navigation were praised - One study showed an average system usability score of 82.33 (top 10% of general usability scores)		low mental health awareness	
Videoconferencing (n=4)	--	--	--	--	--
Virtual reality (n=2)	--	--	One study described the cultural adaptation of the VR space, training materials, and content to local context.	--	--
Social media-based interventions (n=1)	--	--	--	--	--
More than one delivery platform type (e.g., delivered by app or web; OR reviews that included various DMHIs) (n=11)	Three studies reported on fidelity: - two of the studies reported on the same intervention; a treatment fidelity checklist was used in fidelity checks of guidance calls and messages - one study reported audit checks of lay counselors by the lead psychologist to ensure adherence to protocol	Four studies reported on usability: - two studies mentioned the use of a survey to measure usability (MAUQ; 16-item survey of satisfaction), with both demonstrating high satisfaction - one study mentioned piloting was conducted to evaluate, among other constructs, the appropriateness of the intervention - one study reported on feasibility, as measured using compliance and completion rates and	Four articles reported on cultural adaptation: - two studies reported on the same intervention: illustrated narrative was culturally adapted - one study reported an adaptation process involving consultations with stakeholder groups - one study mentioned piloting was performed to clarify language and establish appropriateness	Four articles reported on challenges: - one study mentioned challenges with sustained engagement and inequitable digital access - one study mentioned usability, technical glitches, and connectivity - one study mentioned security and privacy issues - one qualitative study identified low awareness and knowledge of the intervention, concerns regarding effectiveness, efficiency, and usability,	Three articles reported on facilitators: - one study mentioned ability to access clinician transcripts remotely - one review mentioned importance of buy-in from policy makers and clinicians - one qualitative study reported usability, efficiency and effectiveness, and features to booster user engagement

Intervention platform and techniques (n)	Fidelity	Usability	Cultural Adaptation	Challenges	Facilitators
		participant feedback			

Study characteristics

Table 1 presents the main characteristics of the articles included in the rapid scoping review. A total of six main DMHI platforms were identified: 1) mobile app; 2) telemedicine (intervention delivered via instant messaging app; e.g., Whatsapp) 3) web-based programs; 4) videoconferencing; 5) virtual reality (VR; involves immersion of the user in simulated and controlled computer environments)[52]; and 6) social media-based interventions. A total of 14 articles assessed fidelity, 25 explored usability, 27 reported on cultural adaptation, 17 presented challenges to uptake of DMHIs in LMICs, and 15 presented facilitators.

Synthesis of Results

This section presents a summary of the findings from 64 articles that reported the fidelity, usability, and cultural adaptation of DMHIs, along with the challenges and facilitators to their uptake in LMICs. The synthesis was organized by the three research objectives: 1) type of DMHI intervention platform; 2) discussions around their fidelity, usability, and cultural adaptation; and 3) identified challenges and facilitators to their uptake in LMICs. A summary is presented in Table 2, organized according to the type of DMHI intervention platform used, along with other articles that reported the use of more than one type of DMHI.

Types of digital health interventions for depression and anxiety being used in LMICs

This search and review of the 64 included articles showed that of the DMIHs identified in this review, the largest category was mobile apps (36/64, 56.3%). Other DMHIs included telemedicine (intervention delivered via instant messaging app) (4/64, 6.3%), web-based programs (6/64, 9.4%), videoconferencing platforms (4/64, 6.3%), VR (2/64, 3.2%), and social media (1/64, 1.6%). 11 articles (17.2%) reported on delivery of mental health using more than one platform (e.g., delivered by app or web, reviews that included various DMHIs). DMHIs can be stand-alone self-guided programs or incorporate a hybrid model whereby human assistance, either by a therapist (i.e., mental health specialist) to augment their care, or a lay health worker, is available with varying levels of support.

Most of the studies reported beneficial effects of DMHIs, either on improving symptoms of depression and/or anxiety, or other related factors, such as high level of usability, acceptability, and satisfaction during usability and pilot testing. Some studies, however, showed that while there is overall high acceptability of DMIHs, there are also other articles that reported a preference for in-person contact or mixed delivery. Overall, DMHIs show promise as a way to bridge the mental health treatment gap for depression and anxiety in LMICs.

Fidelity, usability, and cultural adaptation

Fidelity

Despite the vast increase of DMHIs in recent years, with many being adapted from existing in-person interventions, only 14 of the 64 articles (21.9%) reported on fidelity. Of these, only three discussed fidelity in relation to the original in-person or paper-based intervention format. One of these studies mentioned adherence to the original intervention structure and format in the adapted digital format.[53]

Another article described the process of involving psychologists and psychiatrists to ensure theoretical alignment of app content with psychosocial components.[54] The last article mentioned that the intervention delivery format (mobile app) ensures that key therapeutic elements are delivered with fidelity and at the appropriate dose using the app's automated features.[55]

Most of the articles that discussed fidelity described the process for ensuring fidelity, or adherence, by lay health workers to the intervention protocol. These articles included fidelity and audit checks of lay health workers by supervisors and reviewing case notes,[56], [57], [58], [59], [60], [61] and use of various tools (e.g., fidelity checklist,[57], [59], [60] PRISM framework[62]). For those reporting on the use of a tool, two articles provided further information, indicating that 5% of the guidance calls and messages were rated (no additional information is provided on who performed the rating or the process). [59], [60] Another article reported that the structured steps in the app made it easier for lay workers to adhere to fidelity when navigating the sessions.[56] Lastly, one study indicated that the intervention itself, which is used for detection and treatment, can increase consistency in diagnosis and treatment. [63] For the articles that reported on measuring fidelity of lay health workers to the intervention protocol, overall it was shown that lay counsellors adhered to the intervention delivery components.

Usability

Less than half of the articles (n=25; 39.1%) described usability testing in some manner, including through usability testing or qualitative exploration. Most of the studies were related to mobile apps (n=19). Of the 25 articles, only six studies reported the use of measures, either standardized (e.g., System Usability Scale [SUS], mHealth App Usability Questionnaire [MAUQ]), or created by the authors for the study (e.g., satisfaction survey) to capture usability.[56], [62], [64], [65], [66] In addition, only nine studies described the usability testing process along with findings in detail, with the majority relating to mobile apps,[53], [55], [62], [64], [67], [68] and the rest pertaining to web-based programs (n=2).[58], [66] Two of the articles were protocol papers that indicated how app development will follow a user-centred iterative design.

Most of the articles that described usability testing outcomes reported high satisfaction. For example, the study by Nurbaeti et al,[69] showed that the evaluation of the app for postpartum depression symptoms in Indonesia was mostly positive, with a large percentage of the participants reporting the following: appearance of the app is adequate (92.67%), easy to download (89.90%), understandable (96.33%), easy to fill-in (94.50%), beneficial (96.33%), new (90.83%), and reflects psychological conditions (90.83%). Another study reporting the protocol for a feasibility cluster RCT to be conducted in Nepal and Nigeria indicated that health workers found the prototypes of the app for the adapted WHO electronic mental health gap action programme intervention guide (e-mhGAP-IG) to be intuitive, appropriate, and feasible for clinical work.[70]

The single relevant article for telemedicine (intervention delivered via instant messaging app), both demonstrated satisfaction.[71] One of the two web-based program articles that reported on usability mentioned poor usability as a major barrier to adherence from the perspectives of both users and e-helpers (lay health workers), while conversely, the other article showed high usability based on the SUS (82.33, or top 10% of general usability scores). The single study from the videoconferencing platform category that described usability reported a high level of satisfaction.

Of the studies that reported more than one delivery platform, four reported on usability testing.[51],

[72], [73], [74] Three of the studies indicated the evaluation of a usability-related construct using particular measures – in this case a usability questionnaire (MAUQ),[72] satisfaction survey,[73] and completion rates with participant feedback.[51] The remaining study mentioned piloting had been conducted to evaluate the appropriateness of the intervention without describing this in detail.[74] Usability was reported as being high (e.g., MAUQ score was 78.5 and the satisfaction survey showed that 92% of participants were very satisfied).

Cultural Adaptation

Lastly, 27 of the articles (42.2%) described a process for adapting the DMHI to the local cultural context. Of these, 20 reported on mobile apps. Various methods were utilized, including a narrative approach involving local women, participatory approach, identification of measures that had been validated in the implementation country or working with local partners to enhance cultural validity where needed, intervention being led by a local partner. Some articles were more vague, indicating simply the importance of identifying what would be culturally acceptable, or that the app was designed for the specific population, or the use of a guide adapted for the health system of the target country. Three other studies discussed cultural adaptation, with all three reporting on web-based programs.[75], [76], [77] These articles indicated that cultural adaptation was conducted with the intervention or culturally adapted approaches were used, mostly resulting in high cultural relevance and acceptability; however, the process was not described in detail. The article that reported on cultural adaptation for VR described the cultural adaptation of the VR space, training materials, and content to the local context.[78]

Four of the 13 articles that reported more than one delivery platform mentioned cultural adaptation.[60], [74], [79], [80] Two of the articles pertained to the same intervention, where the authors indicated the illustrated narrative was culturally adapted.[79], [81] As an example of this, authors mentioned participants could choose the appearance of the avatar used in the program. Other descriptions included an extensive cultural adaptation process involving consultations with multiple stakeholder groups (e.g., psychologists, individuals from target population, community members) and piloting to clarify language and content appropriateness.

Only a few (n=6) of the articles described the cultural adaptation process in detail. For example, one article relating to a DMHI to reduce depressive symptoms among overseas Filipino workers (OFWs) presented their rigorous cultural adaptation method, which involved consultations with psychologists, focus group meetings with OFWs, presenting adapted text and illustrations to the OFWs who again provided feedback and approval, and final translated program was shared with community stakeholders, resulting in a fully adapted Filipino version of the WHO step-by-step intervention.[80] Another article described how the VR space was designed to be similar to the environment of the end users (urban refugee youth in Kampala) and presented in their language of choice, combined with training materials and content adapted to enhance relevance.[78]

Many of the articles discussed the involvement of a broad range of stakeholders in the adaptation process, using a “participatory approach”.[82] For example, one article mentioned how the “the vignettes were developed in consultation with local women who had suffered from depression.”[55] Another article described that to improve cultural fit, “a team of clinical psychologists, psychiatrists, and researchers from the U.S. and India adapted the intervention,” and “modifications were informed by student feedback.”[66]

Challenges and facilitators to their uptake in LMICs

Challenges to uptake

Seventeen of the articles (26.6%) reported on challenges. Ten of the articles described challenges for mobile apps that pertained to the technological system (e.g., system lags, app navigation challenges, bugs); engagement issues (sustained engagement of individuals who are depressed and may have low motivation, high churn, adherence to treatment issues); contextual issues (e.g., illiteracy, technological proficiency, accessibility of mobile phones, data limits, battery charging issues, lack of family involvement); structural barriers (e.g., network connectivity issues, resource constraints); and concerns around privacy and confidentiality.[48], [83], [84], [85], [86], [87], [88], [89], [90], [91] Participants highlighted their concern that many of these challenges contribute to the digital divide, or the division between individuals or populations who have access to and use of digital technology and those who do not.[92] Other challenges mentioned included that of a practice gap between healthcare providers and application developers,[48] and challenges with the online delivery method where participants complete tasks in their own time.[84]

In addition to similar challenges described above, additional challenges reported in relation to web-based programs and those delivered by more than one delivery platform included individuals forgetting their login credentials, time constraints, retention of lay health workers, and stigma.[75], [77] There were also concerns reported around the interventions' efficacy, effectiveness, and usability.[93]

Facilitators to uptake

Fifteen of the articles (23.4%) reported on facilitators. Ten of these articles were related to mobile apps and described various facilitators that supported their uptake and scale-up, including widespread mobile phone usage, built-in supervision and training features, and an app's convenience and integration into existing social (e.g., schools) and health care systems.[83], [84], [86], [87], [89], [94], [95], [96], [97], [98] One of these studies suggested web-based delivery platform rather than app-based as they do not require regular updating, and tailored interventions or distinct adaptations that account for the unique needs of the target population.[84] Other studies reported on the importance of orientation programs and mobilization of community health volunteers,[86] and how an understanding of the intervention and its potential benefits will likely support its uptake.[87] In line with some of the concerns clinicians expressed, described above, one study reported the importance of buy-in from providers and clinical experts, which may be facilitated by demonstrated clinical utility and effiency. Other facilitators were reported in relation to web-based programs or interventions involving more than one delivery platform and included facilitators at the individual level such as being tech-savvy, literate, and have access to devices,[77] and features to boost user engagement.[74] Finally, the importance of cultural appropriateness was emphasized by a number of the articles; see, for example Alavi et al.,[76] and Pozuelo et al.[97]

Discussion

Principal Findings

To our knowledge, this rapid scoping review is the most comprehensive presentation of the studies examining DMHIs for depression and anxiety, their fidelity, usability, and cultural adaptation, along with challenges and facilitators to their uptake in LMICs. The COVID-19 pandemic has led to increases in mental health problems globally and illuminated persistent gaps in care. It has also accelerated the use of DMHIs, though the evidence surrounding these, as exemplified in this rapid scoping review, is mixed. The 64 articles identified in this rapid scoping review reported the use of mobile apps, telemedicine (intervention delivered via instant messaging app, web-based programs, videoconference platforms, VR, social media-based interventions, in addition to instances where the DMHI was delivered by more than one platform (e.g., delivered by app or web).

Fidelity

Active elements of these DMHIs are often modeled on evidence-based psychological interventions developed for in-person delivery,[16] offering further promise to provide scalable effective mental health care. As such, it is critical that the interventions are implemented with high fidelity while balancing the need for necessary adaptations to the digital context, including the different motivational needs and preferences of digital users. Yet, inconsistencies around treatment fidelity have been identified as a main contributor to the mixed evidence on the effectiveness of many DMHIs.[99] Similarly, results from this study showed that only a fifth (n=14; 21.9%) of the articles reported on fidelity, with heterogeneity in process and presentation format. Most of these articles described the process for ensuring adherence by lay health worker to the intervention protocol, rather than outlining the process for ensuring fidelity of the DMHI to its original in-person or paper-based format. Further, only one study mentioned specifically adherence of the DMHI to the original intervention structure, albeit delivered in an automated digital format.[53] Interestingly, two of the articles mentioned that the delivery format of the intervention (app) supported fidelity via the nature of their automated and structured format.[55] This is consistent with past research demonstrating that less complex interventions are easier to implement with high fidelity.[100] As more DHMIs are being developed and adapted from in-person format, it is crucial to ensure intervention fidelity to maintain consistency in intervention delivery across platforms while balancing necessary adaptations to suit digital modes of delivery and the local context. [101], [102]

Usability

Poor usability has been cited as a primary reason for failed adoption of digital health apps,[103] where approximately one-third of users who download health apps stop using them after a short time,[104] often no more than two weeks.[105] Hurdles to app usability include them being ‘too confusing to use’, requiring too much time to enter data, or small screens that display limited information at a time.[103] An additional consideration for individuals with depression include specific symptoms of depression such as low motivation, concentration difficulties, and behavioural avoidance that may make it more difficult for them to engage with DMHIs, posing further challenges to real-world efficacy.[106] Though usability testing is understood increasingly as an important component of app development and evaluation,[107] usability currently remains underexplored in depression app development.[108] Findings from this review reflect this as only 25 (39.1%) of the articles described usability testing in some manner, despite the overwhelming evidence in the literature highlighting how the efficacy of mobile apps can be greatly enhanced by conducting usability testing to determine factors impacting user

adherence and satisfaction.[109], [110], [111] Studies that reported on usability outcomes demonstrated mostly positive findings, with above-average usability and satisfaction scores being reported. Certain challenges to usability were also reported, including a confusing registration process and content that could be improved to be more engaging,[53] which was a barrier to adherence.[58] Despite the generally positive usability and satisfaction scores reported by the various studies, poor usability has been clearly identified as a barrier to sustained user engagement across various digital health interventions.[112], [113] A lack of engagement with the DMHI, regardless of users' self-reports on satisfaction and utility, likely indicates poor usability[114] as usability is a precursor for engagement.[115] Usability is also intricately linked with acceptability, which includes the intuitive attitudes towards the intervention, usage intentions, actual usage, and satisfaction after using.[116] Acceptability is deeply contextualized and intricately linked with prevailing social and cultural norms.[117] It is thus critical to ensure relevance to the local cultural context by ensuring necessary adaptations are made to DMHIs.

Cultural Adaptation

Ensuring interventions are culturally appropriate and relevant is important to their success.[118], [119] While depression and anxiety affect people from all cultures, the experience of these illnesses is culturally bound, shaped by local beliefs, practices, and norms. This cultural variation profoundly influences mental illness expression, patterns of coping and help-seeking, the process of recovery, adherence to treatment, and relationships between individuals and their networks of family, friends, and health care providers.[120], [121] Cultural adaptations to interventions to have more relevance with individuals from ethnic minorities have been shown to have greater efficacy[122] and more favourable health outcomes.[123]

However, limited attention has been focused on cultural adaptations of DMHIs to ensure relevance and acceptability.[18], [19] Twenty-seven of the articles (42.2%) in this rapid review reported on cultural adaptation. However, most of the articles only touched upon the cultural adaptation process undertaken, for example, "clarify[ing] language, and establish[ing] the appropriateness of the developed content within the intended context of use"[124] and "the narrative was adapted to the local context, considering gender, linguistic, and cultural nuances"[59], [60]. Most of the articles pertained to mobile apps.[53], [55], [61], [62], [63], [68], [82], [88], [125], [126], [127], [128], [129], [130], [131], [132], [133], [134], [135] Of the other articles that addressed cultural adaptations, three were related to web-based programs, [58], [66] one related to VR,[78] and four related to articles that encompassed more than one delivery method.[59], [60], [124], [136] While it is encouraging that many of the articles included for review discussed cultural adaptation in some form, there is a need to place more emphasis on the cultural adaptation process to ensure that evidence-based interventions are properly adapted to suit the local cultural context to enhance favourable health outcomes. As reflected in this review, only six of the articles described the cultural adaptation process in detail.

Promisingly, a number of the articles discussed the involvement of a broad range of stakeholders in the development and cultural adaptation process engage a broad range of stakeholders, including experts, end users, and community members, are shown to contribute critical insights for development, implementation, and evaluation.[137] Developing and adapting DMHIs that address the culture and context of the diverse groups in LMICs by including necessary cultural adaptations is critical to increasing relevance and appropriateness to those who often have the greatest need.

Challenges and Facilitators

A number of challenges and facilitators to the uptake of DHMIs in LMICs were reported in the articles. Seventeen of the articles (26.6%) reported on challenges, while 15 (23.4%) reported on facilitators. Unlike the topics of fidelity, usability, and cultural adaptation, where most of the articles discussed mobile apps, articles that discussed challenges and facilitators were spread more evenly across the different delivery platforms, highlighting the consistency of challenges and facilitators.

Challenges to their overall implementation reported in the articles included technological issues (e.g., app instability), engagement issues (e.g., distractions at home), contextual issues (e.g., illiteracy, accessibility of mobile phones), structural barriers (e.g., network connectivity issues), low mental health awareness, and concerns around data privacy and confidentiality. Many of these challenges were perceived as possibly leading to inequitable digital access and contributing further to the digital divide. These findings are consistent with the literature,[7] indicating that, while DMHIs offer an accessible and promising method for delivering mental health care, a number of challenges remain from the end user and developer's side that must be addressed. For example, many of the individuals who use these types of DMHIs may live in rural areas where contextual (e.g., busy with multiple responsibilities such as farming, taking care of family, side jobs) and structural issues (underdeveloped technological infrastructure) may prevent them from engaging fully with DMHIs. Structural issues and digital health literacy have been widely reported in the literature for a number of years.[138], [139] A lack of digital health literacy, especially among the elderly population and those from lower socioeconomic brackets, is one of the main challenges in scaling up digital health interventions.[139], [140] In addition, DMHIs may not be accessible for subpopulations such as racial and ethnic minorities due to language barriers, [141] emphasizing again the importance of ensuring cultural appropriateness.

Clinician buy-in was reported as a challenge to the overall implementation of DMHIs into routine care and centered around time management, regulatory structures and licensure, lack of nonverbal evidence, and payment. Similar challenges have been reported in the literature demonstrating that there has been a reticence by mental health professionals to engage with DMHIs due to the perceived threat on the therapeutic alliance, which some believe can only be established in person.[23], [24] Research suggests there is presently limited theoretical and practical training on novel digital tools and interventions in psychiatry, which influences clinicians' understanding and perceptions of DMHIs.[142] Further to this, the importance of in-person contact in psychotherapy has been widely discussed in the literature.[143], [144], [145] However, Newman et al.,[146] showed that while clinician-assisted treatments are optimal, interventions with reduced in-person contact have also been shown to be effective, cost-effective, and at reduced intensity. This has been researched most heavily in the case of mobile apps, which have seen an explosion in popularity during the COVID-19 pandemic.[147], [148] For example, two systematic reviews on mobile apps (both self-guided and hybrid models) showed effectiveness of the apps at reducing depression symptoms.[15], [71] Nevertheless, clinician concerns need to be addressed to enhance their acceptance of and engagement with DMHIs, particularly for those that are integrated into standard care and thus may require their support. One method may be engaging clinicians more throughout the app development process to provide expert input and also to increase understanding and acceptance of DMHIs.[12] Clinician support will be important to the uptake and expansion of DMHIs with demonstrated effectiveness.[24]

Facilitators of uptake and scale-up of DMHIs in LMICs included widespread mobile phone usage, built-in supervision and training features, and an app's convenience and integration into existing social and

health care systems. Mobilization of community health volunteers – for those hybrid models that require lay health workers for ongoing implementation – was considered an important facilitator, as was ensuring cultural appropriateness to local context by utilizing tailored adaptations. Further, increased mental health awareness was highlighted as an important facilitator to increase understanding of the DMHI and its potential benefits. In addition to demonstrated clinical effectiveness of DMHIs for depression and anxiety, their usage has also been shown to increase mental health literacy and awareness,[138] highlighting that increased app usage may in turn lead to further increased app usage and realization of positive outcomes. In line with the challenge around clinician buy-in, a facilitator was importance of buy-in from clinicians and other providers. Paxling et al[149] demonstrated that certain clinician behaviours, such as task reinforcement, task prompting, self-efficacy shaping, and empathetic utterances were correlated with module completion. Hadjistavropoulos et al[150] showed that certain therapist behaviours (e.g., short emails that lacked detail) were correlated with participants starting fewer platform lessons.

Limitations

A limitation of this work is that we have only included English language papers, leading to an unknown number of articles from LMICs published in languages other than English being excluded from this scoping review. However, we believe that this review of 82 articles identifies many of the key issues concerning DMHIs in LMICs. A second limitation is that this review focused only on depression and anxiety; examination of DMHIs for other mental health conditions may elucidate additional considerations. However, as depression and anxiety are the two most common mental health conditions, [151] and many DMHIs are developed for depression and anxiety,[6], [14], [152] results from this review can inform the further development and delivery of DMHIs for these two conditions, and general rather than condition-specific features of DMHI's that focus on other targets. Finally, research published prior to the the time frame applied to the search for this review, may have contributed additional findings. However, considering the rapid advancement of DMHI and related research stimulated by the COVID-19 pandemic, we believe this review of research published during the applied timeframe captures the most crucial and timely evidence.

Given the rapidly changing landscape of development and delivery of DMHIs, further research is warranted in the near future to capture emergent changes to the landscape on DMHIs, including their fidelity, usability, cultural appropriateness, and challenges and facilitators to their uptake in LMICs. Additional future research should also focus on underexplored areas including an examination of the percentage of the abundance of DMHIs that have no basis in evidence, the potential for harms in the unrestrained development and delivery of DMHIs, and the threats to privacy and security such as potential for financial harm through unregulated mobile apps, including those presented as DMHIs. Lastly, the accelerated growth of artificial intelligence (AI) and its increasing application in various healthcare fields in recent years could transform the landscape of digital mental health, including DMHIs.[153], [154] While AI represents a potential means to advance mental healthcare, there will be an ensuing urgent need to examine in detail ethical implications associated with the integration of AI into digital mental health.

Conclusions

The global shortage of mental health professionals is persistent,[155] with no indication that the gap will

be filled in the forseeable future. DMHIs present as one of the most promising ways to better meet population mental health needs regardless, and to respond in culturally appropriate ways to a wide variety of culturally diverse population groups. Despite the opportunities they offer for reducing the severe and persistent mental health treatment gap, there were several key issues identified in this scoping review that warrant further examination. These include further work on intervention fidelity, user engagement, and cultural adaptation of DMHIs. In addition, various challenges to the uptake of DMHIs in LMICs have been identified, including challenges pertaining to the technological system, contextual issues, structural barriers, and concerns around privacy and confidentiality. These challenges must be mitigated in the ongoing implementation of DMHIs in LMICs to avoid contributing further to the digital divide. In summary, DMHIs in isolation are not a solution to significant mental health system deficiencies, or capable of meeting all mental health needs, but rather, may serve as a low-cost and low-barrier treatment option in low resource settings where community-based care is virtually nonexistent, especially for those DMHIs that are appropriately adapted from evidence-based in-person interventions.

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Conflicts of Interest

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Abbreviations

LMIC: Low-and middle-income country
DMHI: Digital mental health intervention
HIC: High-income country
PRISMA-ScR: PRISMA Extension for Scoping Reviews
VR: Virtual reality
SUS: System Usability Scale
MAUQ: mHealth App Usability Questionnaire
OFW: Overseas Filipino workers

Multimedia Appendix 1: Final PubMed Search Strategy

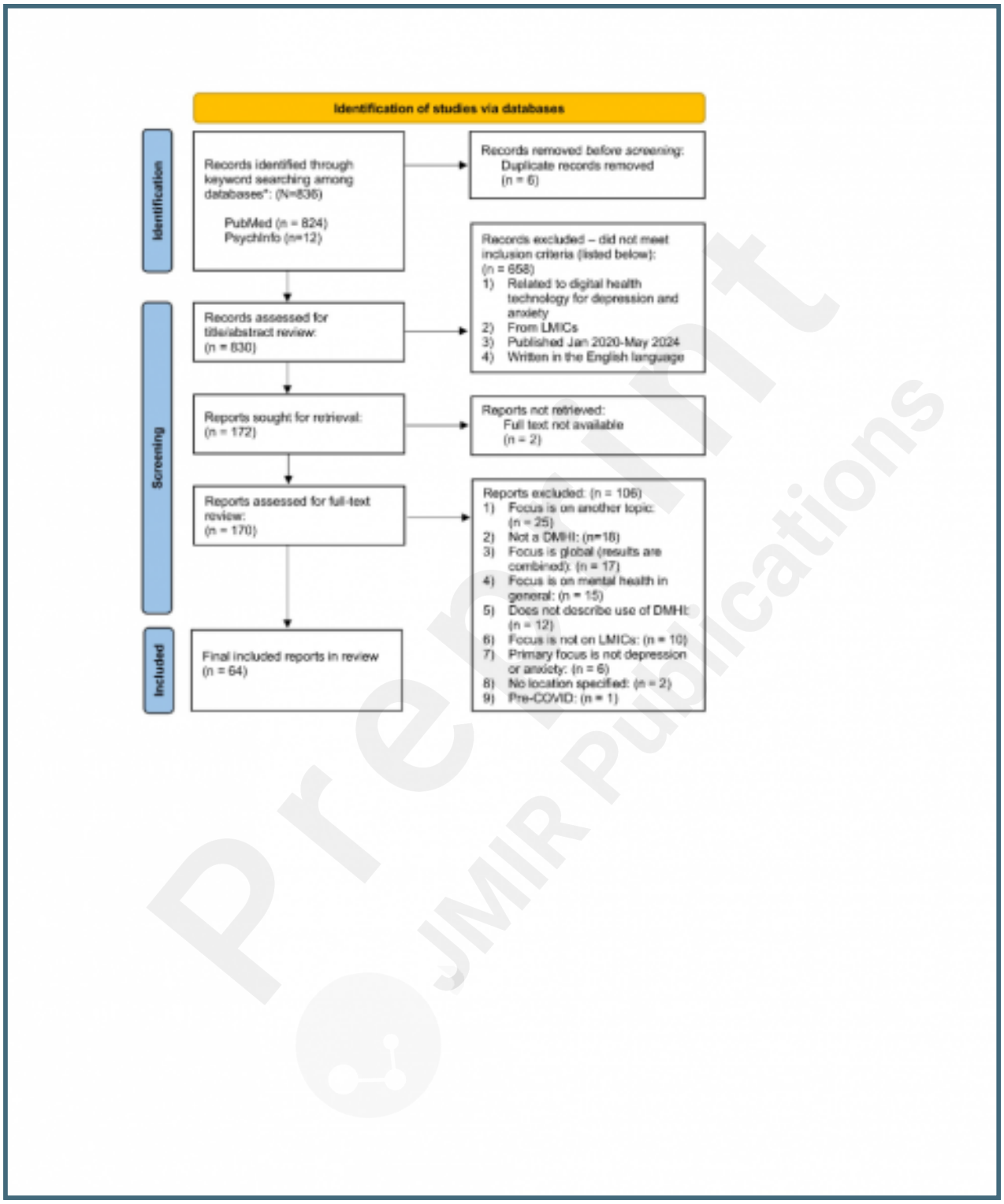
Multimedia Appendix 2: Final PsychInfo Search Strategy

Multimedia Appendix 3: Summary of the Excluded Articles After Full-text Review

Supplementary Files

Figures

PRISMA-Scr flowchart of the included studies in the scoping review.



Multimedia Appendixes

Final PubMed search strategy.
URL: http://asset.jmir.pub/assets/2dd2d941616513bf2ebc9f2f68077ca4.docx

Final PsychInfo search strategy.
URL: http://asset.jmir.pub/assets/68f6a40e15b76002c0cf540fc3714241.docx

Summary of the excluded articles after full-text review.
URL: http://asset.jmir.pub/assets/16496be2613abc69a82e46857d8331e8.docx