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Effectiveness of digital psychological interventions for mental health problems in low-income and middle-income countries: a systematic review and meta-analysis

Zhongfang Fu, Huibert Burger, Retha Arjadi, Claudi L H Bockting

Summary

Background The effectiveness of digital psychological interventions in low-income and middle-income countries (LMICs) remains unclear. We aimed to systematically investigate the available evidence for digital psychological interventions in reducing mental health problems in LMICs.

Methods In this systematic review and meta-analysis, we searched PubMed, PsycINFO, Embase, and Cochrane databases for articles published in English from database inception to March 9, 2020. We included randomised controlled trials investigating digital psychological interventions in individuals with mental health problems in LMICs. We extracted data on demographics, inclusion and exclusion criteria, details of the intervention, including the setting, digital delivery method, control group conditions, number of sessions, therapeutic orientation (eg, cognitive therapy or behaviour therapy), presence or absence of guidance, and length of follow-up, and statistical information to calculate effect sizes. If a study reported insufficient data to calculate effect sizes, the corresponding authors were contacted to provide data that could be aggregated. We did random-effects meta-analyses, and calculated the standardised mean difference in scores of digital psychological interventions versus control conditions (Hedges' *g*). Quality of evidence was assessed by use of the Grading of Recommendations Assessment, Development, and Evaluation approach. The primary outcome was post-intervention mental health problems, as measured by self-reporting instruments or clinical interviews. This study is registered with PROSPERO, CRD42019137755.

Findings We identified 22 eligible studies that were included in the meta-analysis. The included studies involved a total of 4104 participants (2351 who received a digital psychological intervention and 1753 who were in the control group), and mainly focused on young adults (mean age of the study population was 20–35 years) with depression or substance misuse. The results showed that digital psychological interventions are moderately effective when compared with control interventions (Hedges' *g* 0·60 [95% CI 0·45–0·75]; Hedges' *g* with treatment as usual subgroup for comparison 0·54 [0·35–0·73]). Heterogeneity between studies was substantial (I^2=74% [95% CI 60–83]). There was no evidence of publication bias, and the quality of evidence according to the GRADE criteria was generally high.

Interpretation Digital psychological interventions, which have been mostly studied in individuals with depression and substance misuse, are superior to control conditions, including usual care, and are moderately effective in LMICs. However, the considerable heterogeneity observed in our analysis highlights the need for more studies to be done, with standardised implementation of digital psychological intervention programmes to improve their reproducibility and efficiency. Digital psychological interventions should be considered for regions where usual care for mental health problems is minimal or absent.

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For the Persian translation of the abstract see Online for appendix 1

For the Chinese translation of the abstract see Online for appendix 2

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For the Turkish translation of the abstract see Online for appendix 6

For the Romanian translation of the abstract see Online for appendix 7

For the Spanish translation of the abstract see Online for appendix 8

For the Thai translation of the abstract see Online for appendix 9

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Introduction

Together with substance use disorders, mental disorders are among the leading global contributors to the total burden of disease, as measured by the number of years lived with a disability.[1] Compared with high-income countries (HICs),[2] low-income and middle-income countries (LMICs) are disproportionately affected by mental health disorders because of the substantial mental health gap (ie, the gap between available treatment and the number of people with mental disorders in need of care).[3] Indeed, the ratio of available mental health therapists per 100 000 population in LMICs is approximately 0·5% of that in HICs.[4] An analysis[5] published in 2016 estimated that 79–93% of people with depression and 85–95% of people with anxiety are not covered by treatment in LMICs. Inadequate access to mental health care can lead to considerable distress, chronicity, and increased cost of care at the individual level, as well as low productivity and low participation in the workforce at the country level.[6] The scale of this problem is illustrated by the fact that more than 80% of the world population lives in LMICs.[2]

Digital psychological interventions for mental health could contribute to improving access to mental health care in these countries through the advantages of the

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Research in context

Evidence before this study

The existing evidence indicates that psychosocial interventions for common mental health problems are highly effective in LMICs. To investigate their efficacy when delivered digitally, we searched PubMed and PsycINFO from database inception up to March 9, 2020, for reviews and meta-analyses using search terms "psychological intervention", "psychotherapy", or "psychological treatment" AND "digital technology", "e-mental health", "internet", "online" or "web-based", AND "low and middle-income countries", "developing countries", or the exact names of these countries. No language restrictions were applied. Four of 153 retrieved reviews were identified as relevant. Two of these records focused on the overall effect of digital psychological interventions, but failed to generate quantitative evidence. Two of these records focused on specific groups or on a particular geographical region. A comprehensive umbrella review published in 2020 had established robust evidence for the effectiveness of psychosocial interventions in the treatment of common mental health conditions in low-income and middle-income countries (LMICs). However, because no previous meta-analysis of digital psychosocial interventions in LMICs had been done, this previous umbrella review could not draw specific conclusions about the effectiveness of digital psychosocial interventions in this setting. Thus, an overall estimate of the effectiveness of digital psychological interventions in LMICs is missing.

Added value of this study

Our meta-analysis on the effectiveness of different digital psychological intervention formats for mental health problems in LMICs shows that, overall, these interventions were superior to control and usual care. Treatment effects were particularly robust among patients with depression and substance misuse.

Implications of all the available evidence

Digital psychological interventions should be implemented in LMICs, where they can help to extend the reach of mental health care, especially for patients with depression or substance misuse. Policy makers and clinicians in LMICs should consider more mental health-care initiatives that use digital technology to bridge the mental health gap and strengthen local health-care systems. Future research should focus on investigating the effectiveness of digital psychological interventions for the treatment of mental health problems other than depression and substance misuse, and seek to standardise implementation programmes to improve their reproducibility and efficiency.

enormous reach of the internet, remote access, anonymity, and the diversity of formats.[7] A psychological intervention is considered as digital when technology is used in its delivery, such as the internet, computers, mobile phones or tablets, and text messaging services. The use of digital technology in LMICs has increased rapidly over the past several years. A previous report[8] highlighted that 80% of the population in LMICs possess mobile phones, and nearly half of the population can get access to the internet.

Given that there is evidence for short-term effectiveness of digital psychological interventions in HICs,[9,10] it is possible that these interventions would help to reduce the mental health gap in LMICs.[11] Of particular relevance, people around the world, including those living in LMICs, face increasing mental health problems during the COVID-19 pandemic,[12] which has forced millions of people to physically isolate themselves and has presented considerable challenges for mental health-care systems.[13] As recommended by some experts and the UN, digital psychological interventions for mental health problems could have the potential to provide necessary mental support.[14,15]

Nevertheless, the effectiveness of digital psychological interventions in LMICs remains unclear. Previous reviews[16,17] have been unable to do a meta-analysis of the effects of digital psychological interventions because of the insufficient number of available randomised controlled trials (RCTs). Another two relevant reviews involved either a specific group of individuals (two RCTs involving patients with depression in LMICs),[18] or were restricted to one specific region (three RCTs done in Latin America).[19] A comprehensive umbrella review[20] published in 2020, established robust evidence for the efficacy of psychosocial interventions for common mental health conditions in LMICs. However, because no previous meta-analysis on digital psychological interventions in LMIC populations has been done, this umbrella review[20] could not draw specific conclusions about the effectiveness of digital psychological interventions in LMICs.

Long-standing concerns have been raised about the applicability of digital psychological interventions in LMICs. In addition to the potential concern of privacy imposed by technology,[21] the WHO highlights that, "rigorous evaluation of digital health is necessary to generate evidence and promote the appropriate integration and use of technologies".[22] Therefore, a systematic quantitative assessment of the effectiveness of digital psychological interventions in LMICs is needed.

Methods

Search strategy and selection criteria

For this systematic review and meta-analysis, we searched PubMed, PsycINFO, Cochrane, and Embase from inception to March 9, 2020. We built on the search strategy used by Arjadi and colleagues,[17] which was expanded to include terms referring to some newly adopted digital methods (eg, "personal digital assistant", "video game", and "reminder"). Search terms included a combination of Medical Subject Headings and text words (wild cards were used if necessary) indicative of: (1) digital

psychological interventions, (2) LMICs, and (3) RCTs. The full search strings can be found in the appendix 10 (pp 4–12). The reference lists of relevant reviews and the articles citing the included articles were examined to identify additional publications. We included studies in which the following criteria were met: (1) the primary focus was the use of digital psychological interventions in individuals with mental health problems, as defined by specific diagnostic criteria (eg, DSM-5 or ICD-10); (2) the digital psychological intervention was a type of standardised psychological intervention delivered to individuals via digital communication devices through smartphone apps, websites, emails, SMS text messages, videos, audio files, and computer programmes; (3) mental health symptoms were recorded by use of a self-report instrument measuring severity or a clinical interview; (4) participants from LMICs were included; and (5) studies were published in English and in peer-reviewed journals. If more than one study with data from the same patient cohort was identified, the study with the longest patient follow-up period was included. If these studies had the same follow-up periods, the study with the largest sample size was included.

A standardised online platform (Covidence) was used to screen studies. Title and abstract screening and full text screening were done by two reviewers (RA and ZF) independently. Data were extracted primarily by ZF and checked by RA. Disagreements about inclusion were resolved with the help of senior reviewers (HB and CLHB).The same inclusion criteria were applied for the systematic review as for the meta-analysis, except that available data for aggregation were required for the meta-analysis.

Data analysis

We extracted data on demographics, inclusion and exclusion criteria, details of the intervention, including the setting, digital method, control group condition, number of sessions, therapeutic orientation (eg, cognitive therapy or behavioural therapy), the presence or absence of guidance, and length of follow-up, and statistical information to calculate effect sizes. If a study reported insufficient data to calculate effect sizes, the corresponding authors were contacted to request that they provide the aggregate data. Studies were excluded if these data were not provided.

We used the Cochrane Risk of Bias Tool to assess methodological quality of the included studies.[23] The following four domains were assessed: random sequence generation, allocation concealment, incomplete outcome data, and selective reporting. Two independent researchers (ZF and RA) assessed these domains independently, and disagreements were resolved by discussion. Each domain was assigned a "+" (low risk of bias, with a score of 0), a "?" (unclear risk of bias, with a score of 1), or a "–" (high risk of bias, with a score of 2). A total score of 0–2 indicated a low risk of bias (high quality), 3–5 a moderate risk of bias, and 6–8 a high risk of bias (ie, low quality). The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was used to evaluate the overall quality of the evidence.[24]

See Online for appendix 10

Comprehensive Meta-Analysis software (version 3) and the R software programme (version 3.6.2) were used to calculate pooled effect sizes and their 95% CIs. Given the various assessments used to assess different mental health problems, Hedges' *g* as an index of the standardised mean difference was used as a measure of the effect size, thus enabling us to include different outcome measures (eg, Beck Depression Inventory and Patient Health Questionnaire-9 for depression assessment) in the same synthesis. The effect size was conventionally considered as small (Hedges' *g* 0·2), moderate (0·5), or large (0·8). The 95% prediction intervals were also calculated to illustrate which range of true effects can be expected in future research. The between-study component of variance τ^2 was estimated by use of the DerSimonian and Laird method. The number needed to treat was also calculated.[25]

For more on **Comprehensive Meta-Analysis software** see: https://www.meta-analysis.com/index.php?cart=BSCN4722019

If applicable, two meta-analyses were done according to the type of comparison group. We subcategorised comparison groups into two primary types: (1) control groups, including treatment as usual (mixed treatments), assessment only, wait-list control, and active control; and (2) other specified groups, including those in which participants were given single psychological or pharmaceutical interventions.

For more on **Covidence** see https://www.covidence.org

Since considerable heterogeneity was expected, we chose a random effects pooling model for all analyses a priori. Post-intervention outcome data were used to compute Hedges' *g*. Continuous outcome data with means and standard deviations were used to directly calculate Hedges' *g*. If the outcomes were expressed as an event proportion, they were converted to odds ratios and then subsequently converted to Hedges' *g*. We excluded follow-up results, since not all studies had done a follow-up assessment after the intervention period, and follow-up periods differed extensively between studies. The I^2 was calculated to assess heterogeneity. In general, heterogeneity was categorised as low (0–40%), moderate (30–60%), substantial (50–90%), or considerable (75–100%).[26] Subgroup analyses based on type of mental health problem, risk of bias, format of intervention, type of control group, therapeutic orientation, type of guidance, missing values analysis, recruitment setting, region, and diagnosis at baseline were done only if at least three studies were present for each subgroup. All subgroup analyses were done by use of a mixed-effects analysis, in which the random-effects model was used to summarise the studies within the respective subgroups, and the fixed-effects model was used to test for significant differences between these subgroups.

Four preplanned sensitivity analyses were done to examine the effect of: (1) outliers, defined as those

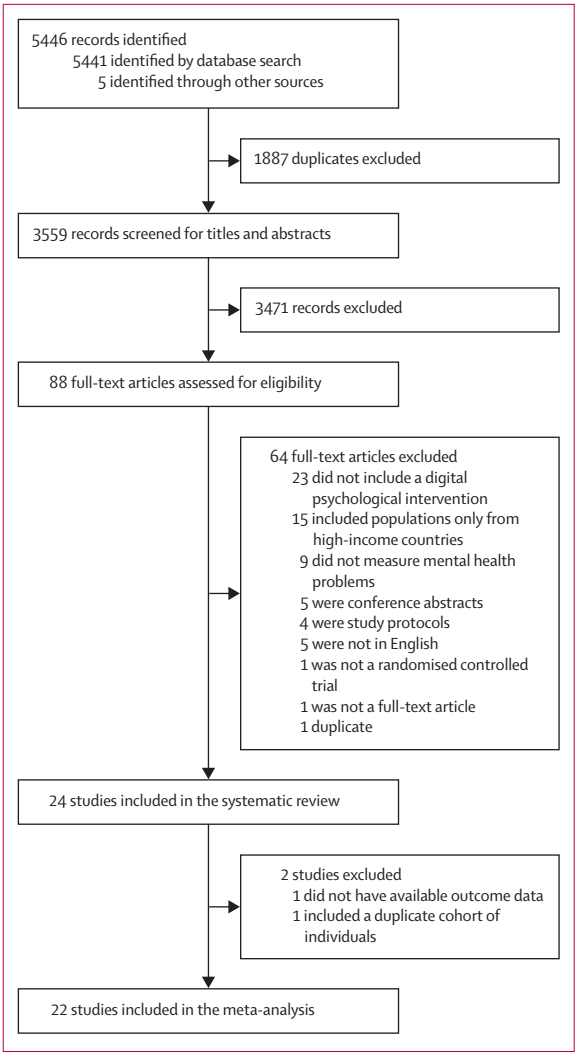

Figure 1: **Study selection**

displaying a 95% CI that did not overlap with the 95% CI of the pooled effect size; (2) blended intervention studies; (3) studies including patients with coexisting physical disease; and (4) studies in which participants from HICs were present. To examine small study effects (eg, those caused by publication bias), funnel plots and the Egger's test were used. Duval and Tweedie's trim-and-fill method was used to estimate the overall effect size, accounting for bias by small study effects. Statistical significance (α level) was set to a p value of less than 0·05 (type 1 error).

The study protocol was registered on PROSPERO, CRD42019137755, and followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA; appendix 10 pp 1–3).

Role of the funding source

There was no funding source for this study. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Overall, 5441 reports were identified through a database search, with a further five reports identified through other sources. 1887 reports were deemed to be duplicates, and a further 3471 reports (titles and abstracts) were excluded. Of the remaining 88 full-text reports assessed for eligibility, 24 studies[27–50] met the inclusion criteria and were included in the systematic review (figure 1). One study[27] did not include information on mental health outcomes, therefore the data from this study were not included in the meta-analysis. Two studies[35,45] included the same cohort of individuals, therefore, the study with the largest sample size (Sanchez and Sanudo[35]) was included in the meta-analysis. A total of 22 studies were included in the meta-analyses, with 31 comparisons: 28 between digital psychological intervention groups and control groups, and three between digital psychological intervention groups and other specified single intervention groups (including face-to-face therapy, pharmacotherapy, and non-digital self-help interventions). We subsequently did two meta-analyses. Since the number of studies comparing digital psychological interventions with other specified single interventions was low, this meta-analysis was considered as exploratory (appendix 10 p 13).

Selected characteristics of studies included in the systematic review are shown in table 1 (additional details are in appendix 10 p 14). A total of 4104 participants (1505 of whom were female) were involved in the meta-analysis (2351 participants in digital psychological intervention groups and 1753 participants in control groups). Within these studies, the average number of participants per mental health problem was 80. The age of participants ranged from 16 years to 45 years. Studies were done between 2012 and 2020 in LMICs including China (n=6), Thailand (n=1), Brazil (n=2), Romania (n=3), Turkey (n=1), Iran (n=3), Indonesia (n=1), Sri Lanka (n=1), Mexico (n=1), and Columbia (n=1), or they were done in multiple sites across different countries (n=2). Participants were recruited from community (n=8), hospital (n=8), nightclub (n=1), and university or school (n=5) settings. Studies targeted mental health problems including depression (n=14), substance misuse (n=7), schizophrenia (n=1), post-traumatic stress disorder (n=3), internet addiction (n=1), and anxiety (social or public speaking; n=4). The severity of mental health problems were mostly measured by self-report questionnaires. Nine studies provided follow-up data, and the length of follow-up varied from 2 weeks to 6 months.

Digital psychological interventions were delivered in several formats, including via websites, smartphone apps, computer, audio-devices, and SMS (text) messages. The shared commonality of these interventions was that their content was adapted from relevant standardised psychological treatments. The therapeutic orientation of

digital psychological interventions for substance misuse was mainly motivational interviewing, and for other mental health problems the therapeutic orientation of these interventions was mainly cognitive behavioural therapy (including mindfulness-based cognitive behavioural therapy). The number of digital psychological intervention sessions differed greatly between studies, from one to 24 sessions (with an average number of nine sessions across all studies). The intervention group in four studies combined digital psychological interventions with other types of intervention, such as face-to-face therapy,[37] pharmacotherapy,[41] and usual care.[44,47] Assessments of adverse events were explicitly mentioned in four[27,41,46,48] of 22 studies, indicating that there were no adverse events in patients who received the digital psychological intervention. In one study,[41] three patients in the Indian sample population reported abdominal discomfort, which was judged to be possibly related to the study medication, and one patient experienced an exacerbation of psychosis after having missed one dose of depot neuroleptics. The remaining 18 studies[28–40,42–45,47,49,50] did not report on adverse events.

	Outcome (measure)	Location	Population	Inclusion criteria	Follow-up	Study groups	Intervention details
Arjadi et al[46]	Depression (PHQ-9)	Indonesia	Community sample	Aged 16 years or older, a PHQ-9 score of ≥10, and met the criteria for major depressive disorder or persistent depressive disorder according to the SCID-5	6 months	(1) Online intervention group: 159 participants (128 [81%] female) with a mean age of 24·5 years (SD 4·9). (2) Active control group: 154 participants (125 [81%] female) with a mean age of 24·5 years (SD 5·2).	(1) Online intervention group: participants used the ACT and FEEL online intervention programme based on Lewinsohn's behaviour activation theory; the programme consisted of eight weekly structured modules, involving psychoeducation on depression and basic skills of behaviour activation; the programme was guided by lay counsellors with supervision from clinical psychologists. (2) Active control group: participants had online psychoeducation, in which they obtained information about psychoeducation on depression and simple tips on how to handle the condition in general.
Burton et al[44]	Depression (BDI-II)	Multiple sites in Romania, Spain, and the UK	Clinic-based sample	Patients with major depressive disorder	2 weeks	(1) Online intervention group: 13 participants (10 [77%] female) with a mean age of 35·3 years (SD 12·1). (2) Treatment as usual group: 14 participants (8 [57%] female) with a mean age of 42·0 years (SD 10·3).	(1) Online intervention group: participants used Help4Mood, which consists of a personal monitoring system, a decision support system, and a virtual agent interface; the computer application can provide daily or weekly mood checks, identify negative or positive thoughts, and provide behavioural activation and relaxation exercises. (2) Treatment as usual group: participants attended an appointment with a local clinician once every 2 weeks.
Christoff et al[43]	Substance use (ASSIST)	Brazil	University sample	Scored as moderate-to-high risk of substance use on ASSIST	None	(1) Online intervention group: 128 participants (77 [60%] female) with a mean age of 24·0 years (SD 5·4). (2) Interview intervention questionnaire group: 106 participants (57 [54%] female) with a mean age of 23·0 years (SD 5·0). (3) Assessment-only group: 99 participants (58 [59%] female) with a mean age of 24 years (SD 5·7).	(1) Online intervention group: participants used a simple and rapid interactive website (ASSIST-MBIc) that was constructed to mirror the content of the interview intervention; the website consisted of an initial screening questionnaire based on the self-report format of ASSIST, explanations of screening scores, and the inclusion of fictitious drug names. (2) Interview intervention: participants had a face-to-face motivational interview based on the WHO ASSIST manual, delivered by traned interviewers. (3) Assessment-only group: individuals were screened by use of the WHO ASSIST manual and received feedback about their scores.
D'Souza et al[41]	Schizophrenia symptoms (PANSS) and depression (CDS)	Multiple sites in India and the USA	Clinic-based sample	Patients aged 18–65 years, diagnosed with schizophrenia or schizoaffective disorder (by use of DSM-IV), and with at least 8 years of education	None	(1) Online intervention group: 27 participants. (2) Online intervention plus D-serine group: 24 participants. (3) D-serine group: 27 participants. (4) Active control group: 26 participants.	(1) Online intervention group: participants received cognitive retraining therapy for 5 h/week, 2–3 days per week, consisting of 20 computer-assisted tasks targeting attention, memory, verbal and visuospatial working memory, and executive function. (2) Online intervention group plus D-serine group: participants received cognitive retraining therapy combined with D-serine. (3) D-serine group: participants received D-serine alone. (4) Active control group: participants received a D-serine placebo and watched non-interactive, neutral videos of popular local television programmes.
Darvish et al[42]	Post-traumatic stress disorder (SRS-PTSD)	Iran	Community sample	War veterans diagnosed with PTSD, who were aged <65 years	None	(1) Online intervention group: 28 participants with a mean age of 47·3 years (SD 3·57). (2)Treatment as usual group: 29 participants with a mean age of 48·4 years (SD 3·6).	(1) Online intervention group: participants received daily SMS (text) messages for 6 months; the messages were written in Persian and focused on mental health improvement and the self-care needs of the patients; message content was decided on the basis of the opinions of both experts and patients. (2) Treatment as usual group: participants received routine psychiatric care in the clinic; all participants received multiple drugs (eg, SSRIs) and psychological consultation.

(Table 1 continues on next page)

	Outcome (measure)	Location	Population	Inclusion criteria	Follow-up	Study groups	Intervention details
(Continued from previous page)							
Durmaz et al[47]	Substance use (proportion of participants who abstained)	Turkey	Outpatient clinic	Patients who were older than 18 years, smoked at least one cigarette per day, wanted help to stop smoking, and used WhatsApp at least 4 days per week	1, 3, and 6 months	(1) Online intervention plus treatment as usual group: 44 participants (16 [36%] female) aged older than 18 years. (2) Treatment as usual group: 88 participants (36 [41%] female) aged older than 18 years.	(1) Online intervention plus treatment as usual group: aside from receiving usual care, participants were also sent daily WhatsApp messages according to their treatment plan, which involved having a plan of action and preventing relapse. (2) Treatment as usual group: participants received usual care by physicians in the clinic, involving a motivational interview or a 45-min face-to-face counselling session for quitting substance use.
Guo et al[48]	Depression (CES-D)	China	Hospital sample	Patients with HIV and depression, and a CES-D score ≥16	None	(1) Online intervention group: 150 participants (8 [5%] female) with a mean age of 28·0 years (SD 5·8). (2) Treatment as usual group: 150 participants (15 [10%] female) with a mean age of 28·6 years (SD 5·9).	(1) Online intervention group: participants received a 3-month intervention programme consisting of two major components; the first component included weekly SMS messages, greetings, and reminders about medication adherence and regular exercise; the second component consisted of short articles on disease management, which were sent via WeChat three times per week. (2)Treatment as usual group: participants received articles on nutrition via WeChat three times per week, and usual care for HIV treatment.
Knaevelsrud et al[40]	PTSD (PDS), anxiety (HSCL-25), and depression (HSCL-25)	Iran	Community sample	Participants with a PDS score of >11	None	(1) Online intervention group: 79 participants (60 [76%] female) with a mean age of 29·1 years (SD 8·2). (2) Wait-list control group: 80 participants (55 [69%] female) with a mean age of 27·2 years (SD 6·5).	(1) Online intervention group: participants received an internet-based intervention, in which they were assigned two structured writing activities each week over a 5-week period; there were three treatment phases; self-confrontation with the traumatic event, cognitive restructuring, and social sharing. (2) Wait-list control group: participants received no treatment for 6 weeks before they were given the same internet-based intervention as the online intervention group.
Liang et al[39]	Substance use (number of days of using primary drug of addiction each week)	China	Community sample	Adults who had used heroin or other substances in the past 30 days	None	(1) Online intervention group: 49 participants (13 [27%] female) with a mean age of 41·7 years (SD 8·7). (2) Active control group: 25 participants (8 [32%] female) with a mean age of 41·3 years (SD 6·8).	(1) Online intervention group: participants received surveys and text messages from S-Health, a self-management smartphone app; participants were asked to complete daily surveys at a time of their choosing, and they could also initiate a survey at any time or frequency by themselves; surveys in S-Health are designed to help patients to better identify triggers, recognise strategies for dealing with these situations, monitor substance use, and deal with cravings. (2) Active control group: participants received only text messages from S-Health (eg, about HIV prevention and other educational materials).
Liao et al[38]	Substance use (verified abstinence)	China	Community sample	Daily smokers who were aged 18 years and older	None	(1) Online intervention group 1: 674 participants (33 [5%] female) with a mean age of 38·1 years (SD 9·7). (2) Online intervention group 2: 284 participants (17 [6%] female) with a mean age of 37·2 years [SD 9·8]). (3) Active control group: 358 participants (24 [7%] female) with a mean age of 38·7 years (SD 9·8).	(1) Online intervention group 1: participants received high frequency text messaging (between three and five text messages per day until 12 weeks after the designated quit day) to motivate and increase behaviour change; after 12 weeks between three and five texts per week were sent. (2) Online intervention group 2: participants received low frequency text messaging (between three and five texts per week until 12 weeks after the designated quit day); after 12 weeks between one and two texts per week were sent. (3) Active control group: participants received one text per week thanking them for being in the study, providing study centre contact details, and reminding them of the time until the end of follow-up; after completion of the trial, the Happy Quit programme booklet was offered to each participant.
Marasinghe et al[37]	Depression (BDI) and substance use (AUDIT)	Sri Lanka	Clinic-based sample	Being admitted to the hospital after attempting self-harm, aged 15–74 years, displaying significant suicidal intent at the interview or showing suicidal ideation (as assessed by the Beck scale)	6 months	(1) Face-to-face and remote intervention group: 34 participants (17 [50%] female) with a mean age of 30·0 years (SD 1·4). (2) Wait-list control group: 34 participants (17 [50%] female) with a mean age of 29·0 years (SD 1·4).	(1) Face-to-face and remote intervention group: participants received a short two-phase mobile intervention involving a face-to-face component and distance follow-up component; the face-to-face component included assessment, meditation, and problem solving; distance follow-up included ten telephone calls post-discharge, continuous access to 5-min audio telephone messages, and weekly SMS reminders for up to 26 weeks. (2) Wait-list control group: participants received the same treatment as the intervention group 6 months after baseline (ie, when they had been discharged from hospital).

(Table 1 continues on next page)

	Outcome (measure)	Location	Population	Inclusion criteria	Follow-up	Study groups	Intervention details
(Continued from previous page)							
Moeini et al[49]	Depression (CES-D)	Iran	University sample	A CES-D score of 10–45	6 months	(1) Online intervention group: 64 female participants with a mean age of 16·2 years (SD 0·7). (2) Treatment as usual group: 64 female participants with a mean age of 16·5 years (SD 0·6).	(1) Online intervention group: participants received a web-based intervention involving CBT; the programme, named Dorehye Amozeshie Dokhtaran, contained seven core modules, including introduction and assessment, awareness-raising, positive psychology, problem-solving, thoughts and feelings, relaxation, physical exercise, and lifestyle modifications; text message reminders were sent to participants before each session. (2) Treatment as usual group: participants received the routine school curriculum
Mogoaşe et al[36]	Depression (BDI-II)	Romania	University samples	Individuals with a BDI-II score of >12 at two consecutive assessments within a 2-week period	None	(1) Online intervention group: 20 participants. (2) Wait-list control group: 21 participants. Mean age of all participants was 22·9 years (SD 4·3).	(1) Online intervention group: participants received an email intervention involving seven scheduled daily sessions, each designed to last about 15 min; five positive and five negative written scenarios were used to train concrete processing; participants in the concreteness training group received two standard forms daily via email describing hypothetical events, one positive and one negative in valence. (2) Wait-list control group: participants received the seven scheduled daily sessions after the post-treatment assessment.
Salamanca-Sanabria et al[50]	Depression (PHQ-9)	Columbia	University samples	Individuals with a PHQ-9 score of 10–19 and who were aged older than 18 years	3 months	(1) Online intervention group: 21 participants with a mean age of 22·2 years (SD 5·4). (2) Wait-list control group: 54 participants with a mean age of 22·1 years (SD 3·9).	(1) Online intervention group: after cultural adaptation, participants received a web-based intervention comprising seven modules of CBT, including self-monitoring, behavioural activation, cognitive restructuring, and challenging core beliefs. (2) Wait-list control group: participants received no treatment until 7 weeks after enrollment.
Sanchez and Sanudo[35] and Baldin et al[45]	Substance use (AUDIT)	Brazil	Community sample	Nightclub patrons who reportes drinking in the past 12 months and were considered to be in a high-risk group (AUDIT score of ≥8) or a low-risk group (AUDIT score of <8)	None	(1) Online intervention group: 225 participants (89 [40%] female) with a mean age of 25·8 years (SD 6·8). (2) Assessment-only group: 240 participants (76 [32%] female) with a mean age of 26·5 years (SD 5·7).	(1) Online intervention group: participants received a web-based intervention of personalised normative feedback consisting of four parts; the first was feedback on the AUDIT score at the investigated moment (with standardised information for each risk level); second was bar graphs comparing their episodic and weekly alcohol consumption with that of other people of the same age and sex in Brazil; third, a personalised estimate of expenditure on alcohol per month and per year; and fourth, general information with data to minimise the adverse consequences of alcohol consumption. (2) Assessment-only group: participants received no feedback after completing the data collection.
Su et al[34]	Internet addiction (YDQ and number of h spent online per week)	China	University sample	Individuals with a YDQ score of 5 or higher, or high-risk internet-dependence (a YDQ score of 3–4), and being online for more than 14 h per week	None	(1) Online intervention in laboratory environment group: 17 participants (10 [59%] female). (2) Online intervention in natural environment group: 12 participants (8 [75%] female). (3) Non-interactive group: 14 participants (12 [86%] female). (4) Wait-list control group: 16 participants (15 [94%] female).	(1) Online intervention in laboratory environment group: participants received the online Expert System for internet addition (HOSC), which was based on motivational interviewing procedures and a client-centered conversation style. It consisted of four models, including ready to start, understanding myself, goal of change, and methods of change. (2) Online intervention in natural environment group: participants received HOSC in their home or dormitory. (3) Non-interactive group: participants used an online non-interactive system (modified from HOSC) under laboratory conditions with untailored feedback. (4) Wait-list group: 1 month after the baseline assessment, participants completed the post-treatment assessment and then received the HOSC intervention in the natural environment.
Thitipitch-ayana et al[33]	Post-partum depression (Stein's post-partum blues question-naire)	Thailand	Hospital sample	Nulliparous mothers, aged 20–35 years, with a Stein's postpartum blues questionnaire score of 3 or higher and an Edinburgh perinatal depression scale score of less than 13	1, 2, and 3 months	(1) Audio group: 39 female participants with a mean age of 23·7 years (SD 3·8). (2) Treatment as usual group: 37 female participants with a mean age of 23·8 years (SD 4·3).	(1) Audio group: participants received the Self-EAR programme, which includes self-empowerment, self-affirmation, and relaxation techniques; the programme was converted into audio files that were uploaded onto an MP3 digital device before it was provided to participants; participants completed the programme at home three times per day for 4 weeks. (2) Treatment as usual group: participants received regular and routine standard post-partum care.

(Table 1 continues on next page)

	Outcome (measure)	Location	Population	Inclusion criteria	Follow-up	Study groups	Intervention details
(Continued from previous page)							
Tiburcio et al[32]	Depression (PHQ-9) and substance use (ASSIST and ADAPT)	Mexico	Hospital sample	Patients with low-to-moderate risk of substance use	None	(1) Online intervention group: 9 participants (2 [22%] female). (2) ASSIST self-help and treatment as usual group: 12 participants (3 [25%] female). (3) Treatment as usual group: 10 participants (4 [40%] female).	(1) Online intervention group: participants received an 8-week web-based programme to be done for 1 h per week; the programme incorporated elements of the CBT approach, such as self-control techniques, functional analysis of substance use, exercises to identify high-risk situations, and action plans to cope with these situations; these CBT strategies were used to identify and transform the negative thoughts associated with depressive symptomatology; in addition to the online intervention, a health professional also participated as a counsellor to accompany and motivate the participants. (2) ASSIST self-help and treatment as usual group: participants received two sessions of ASSIST learning guided by a counsellor and face-to-face CBT for six sessions. (3) Treatment as usual group: participants received face-to-face CBT for eight weekly sessions.
Tulbure et al[30]	Social anxiety (LSAS-SR and SPIN) and depression (BDI-II)	Romania	Community sample	Individuals with a SPIN score of ≥19, an LSAS-SR score of ≥30, and who fulfilled the DSM-IV criteria for SAD on SPSQ	6 months	(1) Online intervention group: 38 participants (22 [58%] female) with a mean age of 30·6 years (SD 8·0). (2) Wait-list control group: 38 participants (23 [61%] female) with a mean age of 27·9 years (SD 7·8).	(1) Online intervention group: participants received internet-based therapy with nine modules; participants were asked to answer essay questions, provide thoughts records, build anxiety hierarchies, describe their exposure exercise, and complete a weekly social anxiety measure; the programme included a pychoeducated introduction on social anxiety, negative automatic thoughts, challenging negative automatic thoughts, behaviour experiments, exposure and self-focus attention, exposure and getting closer to your fears, social skills, and the maintenance plan. (2) Wait-list control group: participants received no active treatment during the 9-week interval and were only asked to complete a weekly social anxiety measure (LSAS-SR).
Tulbure et al[31]	Depression (BDI-II) and anxiety (BAI)	Romania	Community sample	Individuals with a BDI-II score of 14–50 and a current diagnosis of major depressive disorder or dysthymia by SCID-I	None	(1) Conventional internet-based CBT group: 34 participants (30 [88%] female) with a mean age of 29·2 years. (2) Religious internet-based CBT group: 19 participants (16 [84%] female) with a mean age of 32·2 years. (3) Wait-list control group: 26 participants (19 [73%] female).	(1) Conventional internet-based CBT group: participants were given weekly CBT sessions for 9 weeks; the standard component consisted of the core CBT approach for depression with behavioural activation, cognitive restructuring, and sleep improvement techniques; the non-standard component consisted of stress-related growth, forgiveness, altruism, and gratitude techniques; weekly feedback was provided by graduate students under the supervision of a clinical psychologist. (2) Religious internet-based CBT: participants received the same protocol as the conventional group, except that the framework used to augment the CBT intervention was tailored to accommodate the participant's philosophical or religious beliefs. (3) Wait-list control group: participants were asked to complete a weekly measure of depression symptoms (BDI-II) for 9 weeks.
Wang et al[29]	Post-traumatic stress disorder (PDS)	China	Community sample (urban setting)	Individuals with at least two PTSD symptoms in the trauma screening questionnaire	3 months	(1) Online intervention group: 46 participants. (2) Wait-list control group: 44 participants. Overall, participants (67 [74%] female) were aged 18–55 years.	(1) Online intervention group: participants used the web-based intervention My Trauma Recovery, which is a self-help trauma intervention programme consisting of six modules of social support, self-talk, relaxation, identifying trauma triggers, unhelpful coping mechanisms, and professional help. (2) Wait-list control group: participants did not receive any treatment for 1 month before receiving
Wang et al[29]	Post-traumatic stress disorder (PDS)	China	Community sample (rural setting)	Individuals with at least two PTSD symptoms in the trauma screening questionnaire	3 months	(1) Online intervention group: 49 participants. (2) Wait-list control group: 44 participants. Overall, participants (76 [82%] female) were aged 25–70 years.	(1) Online intervention group: participants used the web-based intervention My Trauma Recovery, which is a self-help trauma intervention programme consisting of six modules of social support, self-talk, relaxation, identifying trauma triggers, unhelpful coping mechanisms, and professional help. (2) Wait-list control group: participants did not receive any treatment for 1 month before receiving the same intervention as the online intervention group.

(Table 1 continues on next page)

	Outcome (measure)	Location	Population	Inclusion criteria	Follow-up	Study groups	Intervention details
(Continued from previous page)							
Yang et al[28]	Depression (PHQ-9) and anxiety (GAD-7)	China	Hospital sample	Patients with a PHQ-9 score of >4 or GAD-7 score of >4	None	(1) Online intervention group: 52 female participants with a mean age of 31·3 years (SD 5·0). (2) Treatment as usual group: 50 female participants with a mean age of 30·4 years (SD 3·9).	(1) Online intervention group: participants underwent an 8-week mindfulness intervention programme done on the WeChat platform; the programme included theoretical guidance and meditation practice as primary parts. (2) Treatment as usual group: participants received antepartum health education related to childbirth, breastfeeding, nutrition, and parenting, emotion management skills through lectures, and psychoeducation on depression and anxiety.
Zhu et al[27]	Substance use (DSM-5 clinical interview)	China	Community sample	Met DSM-5 diagnosis criteria for moderate or severe methamphetamine use disorder, and no current use of methamphetamine or any other substances (except nicotine) for at least 7 days	None	(1) Online intervention plus treatment as usual group: 20 male participants with a mean age of 32·7 years (SD 5·3). (2) Treatment as usual group: 20 male participants with a mean age of 35·1 (SD 8·0).	(1) Online intervention plus treatment as usual group: the CCAT app consisted of four cognitive training tasks, including two working memory training tasks, and two methamphetamine-related attention bias control training tasks; the training programme lasted for 4 weeks (20 sessions); participants also received detoxification treatment. (2) Treatment as usual group: participants received regular detoxification treatment in drug rehabilitation centres.

PHQ-9=Patient Health Questionnaire-9. SCID-5=Structured Clinical Interview for DSM-5. BDI-II=Beck Depression Inventory-II. ASSIST=Alcohol, Smoking, and Substance Involvement Screening Test. ASSIST/MBIc=Alcohol, Smoking and Substance Involvement Screening Test-Motivational Brief Intervention by computer. PANSS=Positive and Negative Syndrome Scale. CDS=Calgary Depression Scale. SRS-PTSD=Self-Rating Scale for post-traumatic stress disorder. CES-D=Centre of Epidemiology Scale-Depression. HSCL=Hopkins Symptom Checklist. PDS=Post-traumatic Stress Diagnostic Scale. CBT=Cognitive Behavioural Therapy. AUDIT=Alcohol Use Disorders Identification Test. YDQ=Young's Diagnostic Questionnaire. HOSC=Healthy Online Self-helping Centre. Self-EAR=Self-Empowerment-Affirmation-Relaxation. LSAS-SR=Liebowitz Social Anxiety Scale-Self Report version. SPIN=Social Phobia Inventory. SAD=social anxiety disorder. SPSQ=Social Phobia Screening Questionnaire. BAI=Beck Anxiety Inventory. GAD=Generalised Anxiety Disorder Scale. CCAT=Computerised Cognitive Addiction Therapy.

Table 1: **Characteristics of studies included in the systematic review**

A total of 12 studies[27,29–32,38,40–42,44,46,47] were considered to have a low risk of bias, and 12 studies[28,33–37,39,43,45,48–50] were considered to have a moderate risk of bias (appendix 10 p 17). Specifically, 15 studies[29–32,34,35,38,40–42,44,46–48,50] reported a random component in the sequence generation process. Only seven studies[30,32,38,42,44,46,47] described which procedures of allocation concealment were used. With regards to reporting bias from selective outcome reporting, 13 studies[27,29–32,38,40,42,44,46,47,49,50] provided trial registration information. Regarding attrition bias, 13 studies[27–32,37,38,40,41,44,46,47] reported a reasonable method to eliminate potential bias caused by missing data. The overall estimation of the quality of the evidence, according to the GRADE criteria, was generally high (see appendix 10 p 16).

Using data from the 22 studies (figure 2), we compared the effects of digital psychological interventions with a control group (including assessment only, wait-list control, treatment as usual, and active control groups). The pooled effect size was 0·60 (95% CI 0·45–0·75; prediction interval –0·01 to 1·21), indicating that the number needed to treat was three patients (ie, an average of three patients need to be given the digital psychological intervention for one of these patients to have a favourable outcome when compared with the control). Heterogeneity between studies was substantial (I^2=74% [95% CI 60–83]). Two studies[35,43] were identified as outliers. Both of these studies investigated interventions in individuals with substance use problems in Brazil. The digital psychological interventions were delivered via a website and consisted of psychoeducation on substance use. By contrast with the other studies, which delivered more than four sessions of the intervention to participants, only one session of the intervention was delivered to participants in these two studies.[35,43] After removing these two studies from the analysis, we obtained a similar Hedges' *g* to that observed when all studies were included (0·61 [95% CI 0·48–0·74]; prediction interval 0·15–1·07; I^2=59% [95% CI 33–75]).

Inspection of the funnel plot did not indicate publication bias (appendix 10 p 15). Egger's test of the intercept was not significant (intercept 0·60 [SE 1·12]; p=0·60). Using the Duval and Tweedie's trim-and-fill method, one study might be imputed to adjust the publication bias. After imputation, the overall Hedges' *g* decreased to 0·58 (95% CI 0·44–0·73; prediction interval –0·03 to 1·20)

The intervention groups in four studies[37,41,44,47] used another type of treatment alongside the digital psychological intervention. To avoid the consequent potential for inflation of the treatment effect, we did a post-hoc sensitivity analysis by removing these studies from the meta-analysis. The overall effect size was similar to that observed when all studies were included (0·63 [95% CI 0·47–0·80]; prediction interval: –0·02 to 1·29; I^2=77% [95% CI 64–85]).

We also did a preplanned sensitivity analysis by removing two studies[41,44] that included participants from HICs, and this analysis resulted in a similar effect size to that observed when all studies were included (Hedges' *g* 0·63 [95% CI 0·48–0·78]; prediction interval 0·02–1·24;

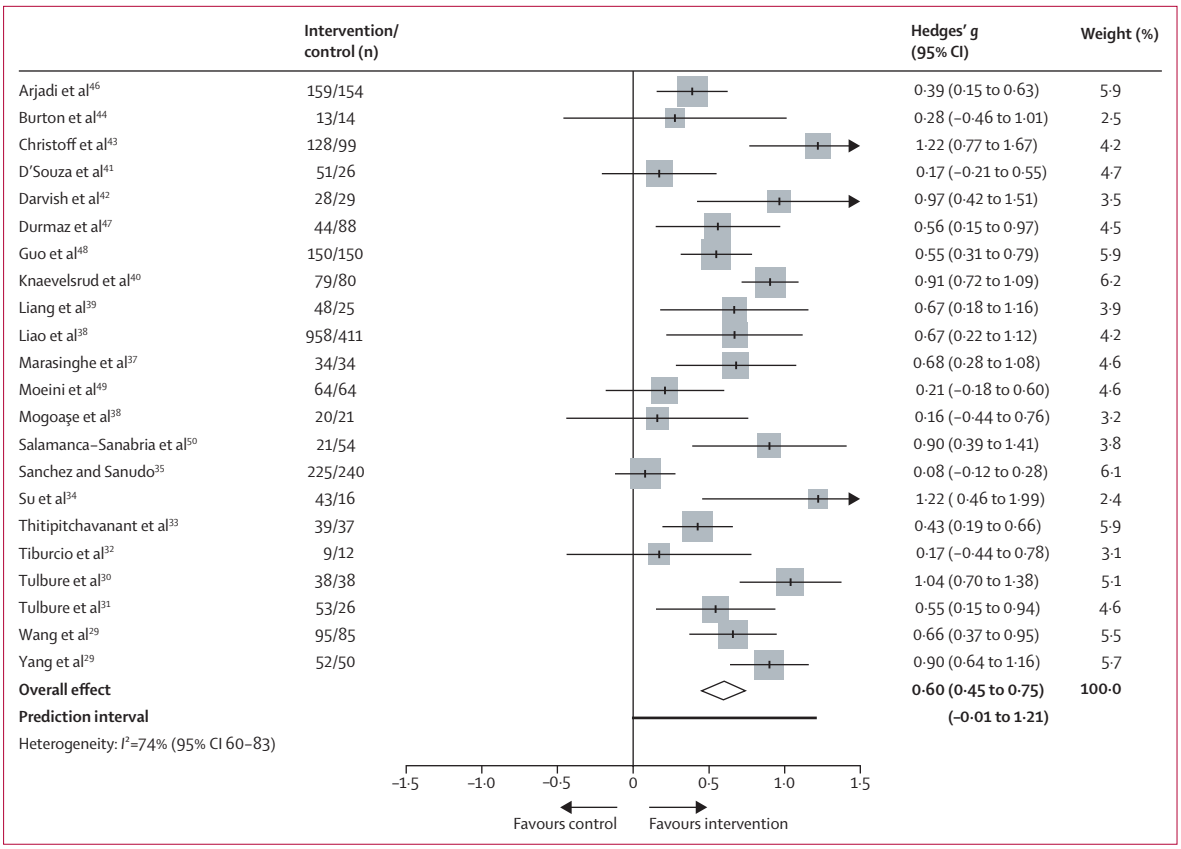

Figure 2: **Effect of digital psychological interventions on mental health outcomes**

I^2=74% [95% CI 60–84]). One study[48] involving participants with HIV was removed in another sensitivity analysis, resulting in an overall similar effect size to that observed when all studies were included (Hedges' *g* 0·60 [0·45–0·76]; prediction interval –0·04 to 1·25; I^2=75% [62–84]).

Subgrouping of studies by different characteristics had no significant effect on the overall effect size (table 2). Subgrouping of studies by different characteristics (eg, by type of psychological symptoms, format of intervention, and type of control group) had no significant effect on the overall effect size.

Discussion

A considerable increase in the number of trials investigating digital psychological interventions since the previous systematic review[17] published in 2014 has enabled us to quantitatively assess the effectiveness of such interventions for mental health outcomes in LMICs. To our knowledge, this is the first study to do such a meta-analysis. Using the results of 22 studies, we found that digital psychological interventions in LMICs showed a moderate aggregated effect size, with a number needed to treat of around three. Most of the included studies focused on depression and substance misuse.

The studies included in our analysis used a diverse range of digital formats for delivering psychological interventions, with content similar to that of traditional face-to-face interventions. The results of our study indicate that psychological interventions perform well when delivered via digital formats. We observed a similar overall effect size of digital psychological interventions in LMICs as has been reported in HICs (eg, in the study by Barak and colleagues,[51] reporting a Hedges' *g* of 0·53). In practice, a predominant question is how digital psychological interventions perform when compared with treatment as usual in local routine care. Eight studies[28,32,33,42,44,47–49] in our meta-analysis compared the effectiveness of digital psychological interventions with treatment as usual (reflecting local routine care). Combining the results of these studies yielded a moderate effect size. Nevertheless, this result needs to be interpreted with caution, as treatment as usual in these eight studies differed considerably (ranging from health education to medication). Meanwhile, the large effect size we observed when digital psychological intervention groups were compared with assessment only or wait-list control groups could be relevant for regions where usual care for mental health problems consists of no care.

Only one study[43] of substance misuse directly compared a computerised intervention programme with a

face-to-face intervention, with results showing that the effectiveness of the digital intervention was superior to the face-to-face intervention (Hedges' *g* 0·70 [95% CI 0·47–0·93]), even though both interventions were based on the same treatment manual. Some indirect comparisons of digital interventions with face-to-face interventions can be made by using findings from previous studies. Effect sizes observed in our study were generally smaller than those of talking therapy in LMICs,[20] and were larger than those pooled from trials of low-intensity psychological interventions delivered by non-specialists in LMICs (with Cohen's d as effect size ranging from 0·34 to 0·49).[52,53]

We examined the treatment effect of digital psychological interventions for different mental health problems, with moderate (depression and substance misuse) to large (anxiety and post-traumatic stress disorder) effect sizes. Depression was most commonly investigated (14 of the 22 included studies): studies included patients with major depressive disorder or depressive symptoms, and specific groups of individuals with depression, including those with HIV[48] and women with perinatal depression.[33] Seven studies[32,35,37–39,43,47] investigated digital psychological interventions in individuals with substance use problems, and our analysis showed that the digital psychological intervention was moderately effective when compared with controls. The interventions in these studies were delivered over a low number of sessions, but attrition in general was considerable. The number of trials on anxiety (n=4) and post-traumatic stress disorder (n=3) included in our study was rather small.

In terms of type of mental health problem, none of the other subgroup indicators were found to be significant moderators of the overall treatment effect. Two subgroups, presumed a priori to be important, failed to explain the heterogeneity between studies. Guidance provided during the digital psychological intervention, which is considered to be important for assisting participants and maintaining adherence, had no significant effect on the overall effect size. This observation is partly consistent with that of previous studies,[54] in which guided internet interventions were not superior to non-guided interventions in patients with depression and social phobia. The absence of effect of guidance on overall effect size could be attributed to mixed definitions of guidance and differences in how guidance is implemented across different studies, which could dilute its influence. The type of control group had no significant effect on the overall effect size, by contrast with previous studies.[55] Treatment intensity was low in the treatment as usual group, which could explain the large effect size of digital psychological interventions, and few studies had an active control group. Both of these factors could have contributed to the insignificant result. Overall, because we were unable to do a meta-regression analysis, we could not exclude the confounding effects of other subgroup factors, such as recruitment setting or type of mental health problem.

	Number of studies	Hedges' *g* (95% CI)	I^2 (95% CI)	p value
Psychological symptoms	..	..	..	0·22
Anxiety	4	0·81 (0·48 to 1·14)	59% (0 to 86)	..
Depression	14	0·57 (0·41 to 0·73)	53% (15 to 75)	..
Post-traumatic stress disorder	3	0·80 (0·60 to 1·00)	0% (0 to 88)	..
Substance misuse	7	0·53 (0·18 to 0·88)	77% (52 to 89)	..
Intervention format	..	..	..	0·72
App	6	0·67 (0·46 to 0·88)	37% (0 to 75)	..
Website	10	0·59 (0·35 to 0·83)	84% (73 to 91)	..
Other	6	0·56 (0·32 to 0·80)	78% (60 to 87)	..
Control group	..	..	..	0·24
Active control	4	0·43 (0·23 to 0·64)	22% (0 to 88)	..
Treatment as usual	8	0·54 (0·35 to 0·73)	54% (0 to 79)	..
Waitlist control or assessment only	10	0·72 (0·45 to 0·99)	84% (72 to 91)	..
Theoretical orientation of intervention	..	..	..	0·89
Behaviour theory	6	0·59 (0·28 to 0·90)	83% (64 to 92)	..
Cognitive theory	15	0·61 (0·45 to 0·77)	64% (37 to 79)	..
Problem-solving	1	NA	NA	..
Missing values analysis	..	..	..	0·74
Complete case analysis	6	0·52 (0·20 to 0·84)	53% (0–81)	..
Intention to treat	11	0·65 (0·50 to 0·81)	63% (30–81)	..
Not reported	5	0·57 (0·16 to 0·98)	85% (66–93)	..
Presence of guidance	..	..	..	1·00
No	8	0·60 (0·35 to 0·86)	77% (55–89)	..
Yes	14	0·61 (0·43 to 0·78)	67% (43 to 81)	..
Recruitment setting	..	..	..	0·54
Community	8	0·69 (0·51 to 0·86)	57% (6 to 80)	..
Hospital	8	0·55 (0·35 to 0·74)	57% (7 to 81)	..
University	5	0·72 (0·25 to 1·20)	76% (41 to 90)	..
Nightclub	1	NA	NA	..
Region	..	..	..	1·00
Asia	13	0·64 (0·50 to 0·78)	57% (21 to 77)	..
Latin America	4	0·58 (–0·02 to 1·19)	88% (73 to 95)	..
Multiple sites	2	NA	NA	..
Other	3	0·63 (0·14 to 1·11)	73% (11 to 92)	..
Quality of study	..	..	..	0·48
High	10	0·66 (0·48 to 0·84)	58% (15 to 79)	..
Other	12	0·56 (0·33 to 0·79)	78% (61 to 87)	..
Diagnosis at baseline	..	..	..	0·81
Yes	6	0·57 (0·28 to 0·86)	7% (29 to 87)	..
No	16	0·61 (0·44 to 0·79)	76% (61 to 85)	..

NA=not available.

Table 2: **Subgroup analysis of digital psychological interventions compared with controls**

It is encouraging that the trials included in our study had a low risk of bias. Most of the studies randomised participants and handled missing values appropriately. Nearly half of the studies included had pre-registered the trial by submitting the protocol to an independent registry, showing the efforts to avoid reporting bias. However, we also found that 70% of studies probably did

not follow rigid rules to conceal the allocation sequence, which could have introduced bias in the overall result. However, together with other strengths, in terms of research design and sample size, the low risk of bias implies a promising acceleration of the research quality in these resource-poor countries.

Some limitations should be mentioned. First, the overall moderate effect size in our meta-analysis could especially reflect the effect of digital psychological interventions when compared with no treatment or minimal treatment. However, this could be relevant for LMICs where usual care is minimal. Additionally, given that most studies have small sample sizes, bias cannot be ruled out. Second, except for depression, effect sizes for other conditions were either pooled from a limited number of studies or accompanied by wide confidence intervals, indicating low precision of the effect. Unfortunately, most of the subgroup analyses were not able to detect sources of this heterogeneity. This observation is consistent with previous meta-analyses on psychosocial interventions in LMICs,[20] suggesting the uncertain credibility of the evidence. Third, because of language barriers, local literature in LMICs was excluded, which could have biased our results. Fourth, most participants included in our analysis had a mean age of 20–35 years. Finally, we were not able to draw conclusions about the long-term treatment effect of digital psychological interventions, given that the follow-up periods were restricted to 6 months.

Several strengths of our analysis should be emphasised. First, the total number of participants involved in our meta-analysis (n=4104) strengthened the reliability of our aggregated results. Second, the high quality of included studies and the low publication bias provide confidence in our overall result. Finally, our analysis provides data on the effect of digital psychological interventions in LMICs that can help researchers to compare results with those from studies done in HICs, and can facilitate communication between various regions. Our study, as a timely quantitative synthesis, could help with the future planning of research in LMIC populations, in terms of mental health outcomes and digital psychological interventions.

The results of our analysis have clinical and policy implications. Our results suggest that digital psychological interventions can be incorporated in clinical practice to manage patients with depression. Second, psychological interventions delivered via a range of digital technologies could be useful clinically for patients aged 20–35 years with various mental health disorders. At the policy level, while more initiatives and investment are required from governmental as well as non-governmental organisations to ensure a sustainable health-care system, innovative and remotely delivered digital psychological interventions could make a valuable difference in treating mental health problems, particularly during the COVID-19 pandemic. However, we need to remain aware of the potential risks of digital technology, and the unintended consequence of widening inequalities in mental health care between people who can and cannot get access to the internet and mobile devices, for example, children and older individuals, and extremely impoverished groups.

Suggested future directions for the research community include the rigorous evaluation of the effects of digital psychological interventions for specific mental health problems, particularly those that have been investigated in fewer than ten studies (ie, anxiety, post-traumatic stress disorder, and substance misuse). Examining the long-term treatment effects of digital psychological interventions is also important, given the chronic nature of most mental health problems. Research is needed to identify specific moderators of treatment effects so that more precise and tailored interventions can be delivered. In addition, the inherent heterogeneity of the interventions, research contexts, and implementation approaches analysed in our study suggest that comprehensive international guidance and standardised implementation programmes are needed to improve reproducibility and comparability.

In conclusion, the results of our systematic review and meta-analysis suggest that digital psychological interventions in mental health care hold promise in bridging the mental health-care gap in low-resource countries. This is particularly relevant during and after the COVID-19 pandemic, when physical distancing, the socioeconomic consequences of quarantine measures, and the loss of social support threaten public mental health.

Contributors

CLHB and RA conceived the study. CLHB, ZF, HB, and RA designed the project, protocols, and the literature search strategy. ZF and RA did the literature search and screened the records, extracted the data, and selected the articles, under the supervision of CB and HB. ZF and HB analysed the data and wrote the manuscript. HB, RA, and CB contributed substantially to the revision of manuscript.

Declaration of interests

We declare no competing interests.

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