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Review: Can digital mental health interventions bridge the 'digital divide' for socioeconomically and digitally marginalised youth? A systematic review

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Background: Digital mental health interventions (DMHIs) have the potential to improve the efficiency, accessibility and effectiveness of mental health services for young people, with the potential to reach socioeconomically and digitally marginalised young people with mental health needs who would otherwise not seek help in person. This review aims to investigate the characteristics, acceptability and efficacy of DMHIs specifically developed for socioeconomically and digitally marginalised youth. **Method:** Key databases were searched widely and systematically (EMBASE, MEDLINE, PsycINFO, OpenGrey). Final inclusion in this review required studies to evaluate DMHIs specifically targeting socioeconomically and digitally marginalised children and young people through a broad range of research designs. **Results:** Ten studies, describing seven DMHIs, were included in this review. Studies varied in terms of methodology, population, intervention, outcome measures, technologies used and methodological quality. Qualitative and quantitative results are synthesised across three key phenomena of interest: effectiveness, acceptability and feasibility. Findings suggest that there is moderate but limited evidence supporting DMHIs for improving mental health outcomes among these populations. **Conclusions:** While there is moderate evidence suggesting that digitally delivered interventions can be effective in improving mental health outcomes among socioeconomically and digitally marginalised youth, more high-quality research is needed in order to determine whether DMHIs can fully bridge the so-called 'digital divide'.

Key Practitioner Message

- Digital mental health interventions (DMHIs) for socioeconomically and digitally marginalised youth are not widely researched.
- This systematic review fills a gap in the literature by investigating digitally delivered interventions, utilising a range of technologies, to improve mental health outcomes among digitally and socioeconomically marginalised youth.
- DMHIs appear to be a promising option for meeting the mental health needs of socioeconomically and digitally marginalised children and young people, although the current evidence base is limited.
- More high-quality research is needed to fully determine whether DMHIs can truly bridge the 'digital divide'.

Keywords: Mental health; intervention; adolescence; e-health; social inequality

Introduction

It is estimated that three quarters of young people with mental health problems in the U.K. receive no treatment (Hollis et al., 2017). Socioeconomically marginalised youth are two to three times more likely to develop mental health problems compared to more socioeconomically advantaged peers (Reiss, 2013). Socioeconomic deprivation is associated with increased mental health stigma, lower mental health literacy and negative help-seeking attitudes (Ibrahim et al., 2019; Robards, Kang, Usherwood, & Sanci, 2018). Across various geographic and socioeconomic contexts, digital mental health interventions (DMHIs) have been deemed highly adolescent-appropriate (Goodyear & Armour, 2018; Robards et al., 2019) as the integration of technology is

transforming mental healthcare provision (Orlowski et al., 2016). This systematic review considers whether DMHIs have the potential to bridge to so-called 'digital divide,' by investigating the effectiveness, acceptability and feasibility of DMHIs for treating the mental health needs of socioeconomically and digitally marginalised youth.

Digital marginalisation and the digital divide

The coronavirus pandemic shed light on the complexity of digital inequalities and the so-called digital divide like never before (Aissaoui, 2021; Enyioha & Cotman, 2021; Nguyen et al., 2020). Research has shown that digital inequalities exist across socioeconomic levels, with lower-income individuals and families experiencing greater digital exclusion (Enyioha & Cotman, 2021;

Gonzales, McCrory Calarco, & Lynch, 2020; Katz, 2017; Livingstone & Helsper, 2007). Rather than framing digital inequalities through binary access of the digital divide, Katz (2017) describes a continuum of digital connectivity along which all technology users are placed, similar to the gradations of digital inclusion proposed by Livingstone and Helsper (2007). Those on the lower end of the digital connectivity spectrum, who experience greater digital exclusion, tend to also experience socioeconomic marginalisation (Katz, 2017; Livingstone & Helsper, 2007). Digitally marginalised youth may experience the reality of being underconnected through the internet being too slow, having to share devices with multiple individuals, having services disconnected due to nonpayment or travelling to schools or libraries to use specific technologies (Katz, 2017; Katz, Moran, & Ognyanova, 2019). Socioeconomic differences in digital connectivity exist in how, not if, young people use technology and the internet (George et al., 2020; Harris, Straker, & Pollock, 2017). This issue is fundamental for the development and implementation of DMHIs for young people.

By understanding the digital divide as a spectrum of digital connectivity (Katz, 2017; Livingstone & Helsper, 2007), one can identify communities of young people who exist on the lower end of the digital connectivity spectrum, including but not limited to socioeconomically marginalised youth. For example, homeless youth experience great adversity with unique social- and health-related needs and are highly likely to be digitally marginalised, both in access to devices and internet connection (Barnes, Gower, Sajady, & Lingras, 2021; Sathi, 2018). Other communities may be complexly and less evidently identifiable as digitally marginalised, such as those living rurally. Rurality may affect internet access, thus impacting digital connectivity, however, this does not necessarily translate to socioeconomic status nor other forms of marginalisation (Aissaoui, 2021; Livingstone & Helsper, 2007; Watts, 2020). Other communities which may experience hidden digital exclusion and inequality are indigenous and Aboriginal communities, shaped by the present and historic impact of colonialism (Rodriguez, George, & McDonald, 2017; Temple & Russell, 2018; Tesfaghiorghis & Altman, 1991). Indigenous communities around the world face social and economic inequality, which significantly affects outcomes for education, employment, health and digital access (Stephens, Szabó, & Breheny, 2022; Temple & Russell, 2018; Tesfaghiorghis & Altman, 1991). In order to investigate the evidence-base of DMHIs for digitally marginalised youth thoroughly and systematically, it is essential to include communities whose digital exclusion may be uniquely intertwined, and potentially overlooked, within other forms of social inequality.

Digital interventions for digitally marginalised youth

Digital mental health interventions have the potential to improve the efficiency, accessibility, acceptability and effectiveness of mental health interventions (Hollis et al., 2017; Murray et al., 2016), as technology-based interventions may have the potential to reach marginalised young people with mental health needs who would otherwise not seek help in person (Pretorius, Chambers, & Coyle, 2019).

While socioeconomically disadvantaged youth are less likely to seek formal help for mental health issues face-to-face (Ibrahim et al., 2019; Robards et al., 2018), this socioeconomic disparity in help-seeking behaviour may not necessarily exist digitally (Pretorius et al., 2019; Robards et al., 2019). With physical healthcare services, marginalised youth tend to integrate technology into their help-seeking behaviours similar to socioeconomically advantaged peers, although this has yet to be explored regarding mental health services (Pretorius et al., 2019; Robards et al., 2019). Young people, increasingly seen as digital natives (Goodyear & Armour, 2018), may feel more comfortable discussing mental health online rather than face-to-face (Gibson & Trnka, 2020).

There is currently very limited research into mental health interventions for marginalised youth, let alone digital interventions (Das et al., 2016; Fazel, Patel, Thomas, & Tol, 2014; Vojt et al., 2018). To the authors' knowledge, no systematic review has examined the evidence base for DMHIs, utilising a range of technologies, targeting mental health outcomes among digitally and socioeconomically marginalised youth. A systematic mapping review of available digital and face-to-face interventions for vulnerable adolescents by Vojt et al. (2018) identified a 'remarkable lack of evidence' (p. 31) for mental health interventions for economically, socially or contextually marginalised youth. Schueller, Glover, et al. (2019) and Schueller, Hunter, et al. (2019) reviewed key examples of DMHIs for underserved communities, however, it did not follow a systematic review design. Moreover, they included a range of marginalised communities beyond those likely to be digitally marginalised and focused primarily on adult populations (Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019). A systematic review by Stiles-Shields et al. (2020) synthesised the literature investigating phone-based interventions for marginalised youth, with the aim of highlighting future research directions. Their review did not focus specifically on mental health, but rather on a range of health outcomes, including pain management, violence exposure and asthma.

This systematic review investigates the effectiveness of DMHIs in treating the mental health needs of socioeconomically and digitally marginalised children and young people. This review analyses the quality of the included studies and the characteristics of the interventions. Finally, it aims to explore the implications of these findings for DMHI development, implementation and evaluation for future research and practice.

Methods

This review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher, Liberati, Tetzlaff & Altman, 2009; Page et al., 2021) and the Joanna Briggs Institute (JBI) guidance for mixed method systematic reviews using a convergent integrated approach (Aromataris & Munn, 2020). It followed a systematic process across a series of consecutive stages, summarised in the flow diagram in Figure 1 and as described below.

In June 2020, a systematic literature search was conducted in English in the following databases: EMBASE, PsycINFO, MEDLINE and OpenGrey.

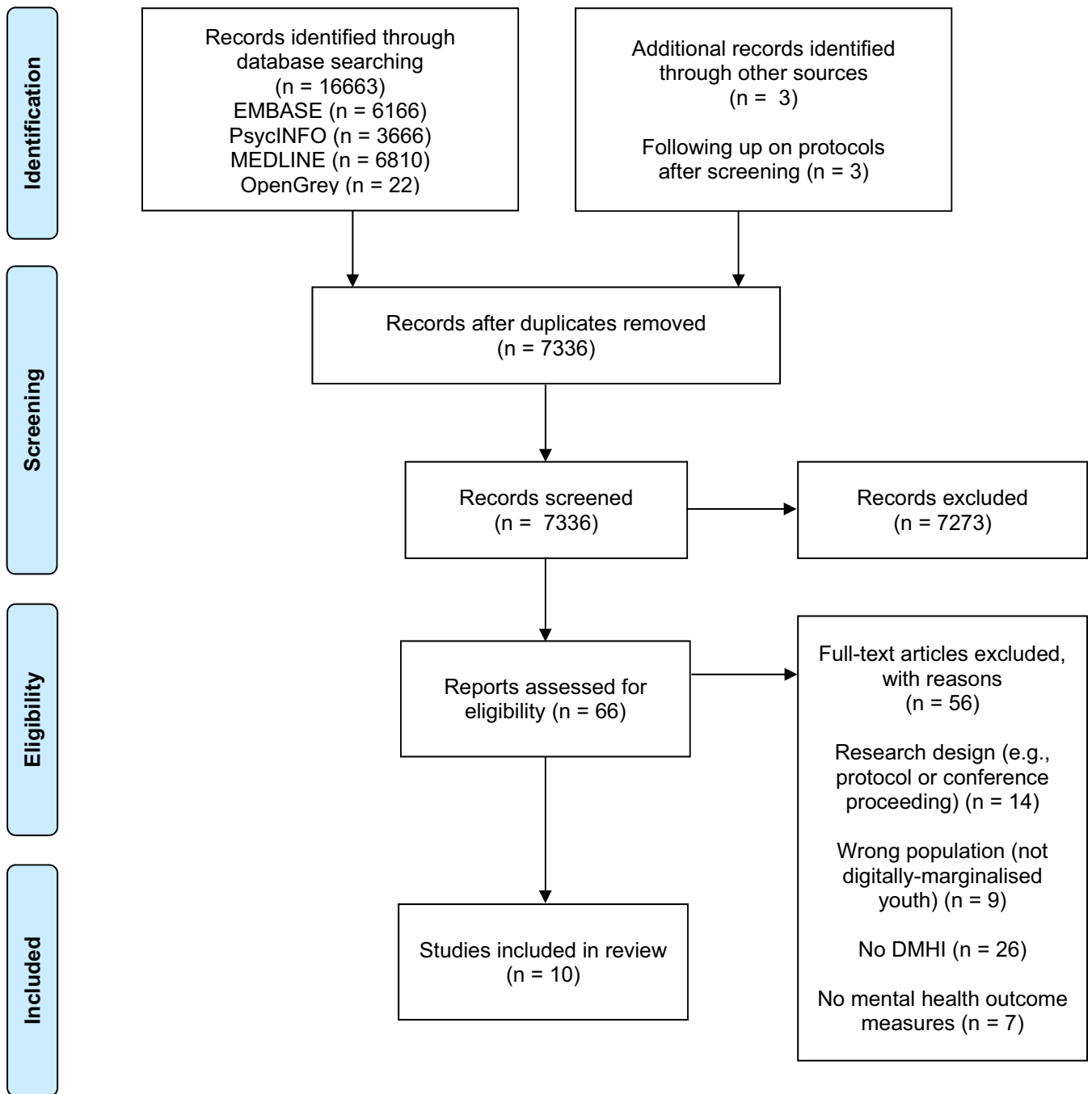


Figure 1. PRISMA flow diagram of search

Eligibility and inclusion criteria

In accordance with guidance from Joana Briggs Institute (2014, 2020), the eligibility criteria are outlined according to population, intervention, context and outcome measures (see Table 1). Search terms are presented in Table 2 from which a search string was formulated for each database.

Final inclusion in this review required empirical research of DMHIs specifically targeting socioeconomically and digitally marginalised children and young people. A broad range of research designs was permitted, providing that the study included any qualitative or quantitative evaluation of the intervention. This review defined young people as individuals up to the age of 25 years old, and inclusion criteria required at least 50% of the study sample to be under this age threshold. Included studies were required to focus on the mental health outcomes of children and adolescents that experience digital

and socioeconomic inequality. This review defined DMHIs as digitally delivered or technology-enhanced interventions targeting mental health outcomes. Types of outcome measures include quantitative and qualitative mental health measures, such as symptom severity (e.g. depressive symptoms, anxiety, stress/distress), suicidality, mood/emotional regulation, coping skills, trauma, social support, quality of life and psychological well-being. Types of measures of digital and socioeconomic marginalisation include area-based measures (e.g. indices of multiple deprivations), school-based measures (e.g. eligibility for free school meals), identity-based measures (e.g. belonging to a group likely to experience digital marginalisation) and income-based measures (e.g. household/parental income).

Search strategy

While a range of research designs was eligible for inclusion, studies needed to report empirical findings, thus excluding

Table 1. Inclusion criteria

PICO	Specification
Population	Children and young people up to the age of 25 years, who experience socioeconomic and digital marginalisation
Intervention	Digital mental health interventions aiming to improve the mental health outcomes of digitally and socioeconomically marginalised youth
Context	Interventions must be digitally delivered via any mode of technology (e.g. phone/smartphone, computer, or other digital devices). Technology-enhanced interventions are included if the digital delivery is a critical intervention component
Outcome	Interventions must target any mental health outcome(s) as a primary outcome measure(s)

review or meta-analytic designs. To minimise the risk of publication bias, grey literature was eligible for inclusion, in addition to peer-reviewed articles. The chosen databases (EMBASE, PsycINFO, MEDLINE, OpenGrey) were selected for their relevance to psychology, social sciences, medicine and allied health professions. Additional search strategies included checking reference lists and following up on published protocols and conference proceedings. Included studies were limited to those available in the English language, due to a lack of resources for translation. No date range was applied, however, the use of digital technologies in mental health treatment is inevitably limited to the timeframe in which these technologies have existed.

Given the relatively small body of research in this area, search terms were kept fairly broad (see Table 2 for key terms). This broad search strategy aimed to ensure that relevant publications using differing terminology were captured in the search.

Study selection

The selection process was reported in accordance with the PRISMA 2020 framework (Page et al., 2021; see Figure 1). Rayyan QCRI was used to keep detailed records of the screening and selection process (Ouzzani et al., 2016). The screening process was comprised of two phases, as part of a larger aim of the researchers to understand the extent to which socioeconomic and digital marginalisation has been considered in digital mental health research among child and youth populations. The initial phase screened for studies of digital or technology-based mental health interventions for children or young people in a community-based or nonclinical sample, on the basis of title,

keywords and abstract. This phase aimed to provide a broad overview of the available literature on DMHIs for children and young people in general.

The subsequent phase narrowed the eligibility criteria to include any measure of marginalisation and socioeconomic status. Following this initial stage, the remaining records were systematically searched for titles, abstract and keywords, with the full search string to include terms relating to digital and socioeconomic marginalisation (outlined in Table 2). Only studies that described any measure or reference to socioeconomic status and marginalisation were included for screening at full-text levels. All records were screened by one reviewer, with a subsection screened by an additional reviewer. Disagreements were resolved through discussions to reach a consensus among all reviewers.

Data extraction

The following data were independently extracted by one reviewer: author(s), study design, participant characteristics, intervention characteristics, outcomes, results and any other themes relating to the phenomena of interest (see Tables 3 and 4). This information was checked by all reviewers. Discussions to reach a consensus were held to resolve any disagreements. A summary of the analysed data is presented in the results section.

Quality assessment

The methodological quality of all included studies was assessed using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (QualSyst) tool (Kmet, Lee, & Cook, 2004). The QualSyst tool was designed for evaluating both qualitative and quantitative studies, allowing for parallel assessment of various methodologies (Kmet et al., 2004). Items are scored against 14 dimensions for quantitative studies and 10 dimensions for qualitative studies, based on the extent these criteria have been met (2 = yes, 1 = partial, 0 = no, and N/A). Criteria include research objectives, study design, sampling, random allocation and/or blinding, data collection, data analysis, confounding, verification and reflexivity. Items that were not applicable were removed from summary score calculations. The final agreed summary scores are represented as a percentage, with higher scores indicating higher methodological quality. This approach to quality assessment has been used effectively in other reviews of DMHIs (Ashford, Olander, & Ayers, 2016; Gindidis, Stewart, & Roodenburg, 2019; Strudwick et al., 2021) and mental health interventions for marginalised populations (Lawrence, Rooke, & Creswell, 2017; Taylor, Radford, & Calia, 2022; Wright, Jordan, & Lazzarino, 2021).

Risk of bias in randomised controlled trials was further assessed using the Cochrane Risk of Bias 2 (RoB2) tool, which explores five categories of potential bias, resulting in an overall

Table 2. Search terms

PICO Criteria	Definition	Search string (synonyms connected by OR)
Population	Socioeconomically and/or digitally marginalised children and young people	Adolescen*, youth, AND Socioeconomic*, young people, socio-economic*, young person, young person, income, low-income, child* low income, marginaliz*, marginaliz*, minorit*, indigenous, homeless*
Intervention Context	Mental health intervention Digitally delivered	Therap*, intervention*, program*, treatment* Digital*, smartphone, mobile phone, mHealth, m-Health, online app*, mobile app*, internet, e-health, DHI, computer*, web-based
Outcome	Any mental health outcome(s)	Mental health, mental wellbeing, psych*, wellbeing, resilien*, happiness, depress*, anxiety, stress, distress

Table 3. Study and participant characteristics

Article	DMHI	Research Design	Population	Sample	Age Mean (SD)	Age range	Key findings
Anton et al. (2016)	TE-HNC	Pre-postcase series analysis	Low-income caregiver-child dyads (children above clinical cut-offs for behavioural difficulties)	9 families	5 years (SD = 1.18)	3–8 years	The inclusion of technology in this intervention improved engagement and adherence compared with the no-technology condition
Arjadi et al. (2018)	GAF-ID	RCT	Indonesian community sample of low-income and middle-income young people meeting clinical criteria for depression	n = 313 (experimental group = 159; control group = 154)	24.45 years (SD = 4.93)	16+ years	The web-based intervention effectively reduced depressive symptoms in the DMHI group compared to control, postintervention and at 3-month follow-up
Chandra, Sowmya, Mehrotra, and Duggal (2014)	MOGGU	Qualitative pilot	Adolescent girls aged 16–18 years living in the urban slums of Bangalore	n = 40	16.8 years (SD = 1.68)	16–18 years	Participants responded positively to this DMHI and wanted it to continue, however, issues of confidentiality were raised
Glover et al. (2019)	Pocket Helper 2.0	Feasibility pilot for RCT	Homeless youth in Chicago	n = 100	17 years (SD = 3.90)	16–25 years	This automated smartphone-based intervention demonstrated feasibility and acceptability among young homeless populations
Jones et al. (2014)	TE-HNC	Feasibility pilot for RCT	Low-income families of 3- to 8-year-old children with clinically significant disruptive behaviours	n = 19 (n = 9 in DHI group, n = 10 in nondigital group)	5.67 years (SD not reported)	3–8 years	Significance testing was precluded; however, other indicators suggest that the inclusion of technology in this intervention may boost improvements in child behaviour
Neal-Barnett et al. (2019)	BYOTS	Pre-post/Mixed methods	Black adolescent girls enrolled in free school meal programme in a low-income school district	n = 72	Not reported	12–15 years	This technology-enhanced intervention showed significant improvements in negative thinking and anxiety symptoms
Schueler, Glover, et al. (2019), Schueler, Hunter, et al. (2019)	Pocket Helper	Feasibility pilot for RCT	Homeless youth in Chicago	n = 35 (only n = 22 completed postintervention)	19.06 years (SD not reported)	18–24 years	No significant changes between pre-/postmental health outcome measures, however, qualitative findings indicated high satisfaction with this DMHI
Shepherd et al. (2015)	SPARX	Codesign	Maori youth in New Zealand and their families	n = 26	Not reported	16–18 years	This DMHI was considered to have good face validity and was seen as appealing and culturally relevant
Tighe et al. (2020)	iBobby	Feasibility/acceptability qualitative pilot	Young Aboriginal and Torres Strait Islander community members	n = 13 (from RCT below)	24.15 years (SD = 4.70)	18–35 years	Nonsignificant quantitative improvements in psychological outcomes. Qualitative interviews suggest the acceptability, helpfulness and cultural relevance of this DMHI
Tighe et al. (2017)	iBobby	RCT Pilot	Young Aboriginal and Torres Strait Islander community members	n = 61 (n = 31 intervention and n = 30 to waitlist)	26.25 years (SD = 8.13)	18–35 years	Significant pre-/postimprovements in suicidal ideation, depression and psychological distress, however only the latter two were significant compared to the waitlist control

assessment of bias as 'Low risk,' 'Some concerns,' 'High risk' or 'Unclear' (Higgins et al., 2019). Information about the studies' randomisation processes, deviations from intended interventions, missing outcome data, measurement of outcomes and reporting of results were entered into a pre-established template as outlined by the *Cochrane Handbook of Systematic Reviews* (Higgins et al., 2019). This tool was chosen as it provides a reliable, structured framework for assessing various domains of bias (Higgins et al., 2019).

The methodological quality of study was independently assessed by two reviewers, with an additional independent reviewer brought in for quality control. Uncertainties and disagreements were discussed to reach consensus. A Cohen's Kappa test indicated substantial agreement between reviewers, with an interrater reliability of $k = .76$.

Results

Study inclusion

The initial search returned 16,663 articles, resulting in a total of 7336 after duplicates were removed. A total of 44 records were assessed for eligibility at full-text levels, including the 41 records identified through the search strategy above, and an additional three records identified by following up on protocols identified in screening. A total of 10 articles met the final inclusion criteria. Figure 1 is a flow diagram detailing the review process.

Quality assessment

The methodological quality of all studies was assessed using the QualSyst tool (Kmet et al., 2004). The results of the QualSyst assessment can be found in Table 5. Overall, the quality of studies varied with a mean score of 77.5% for qualitative studies and 68.6% for quantitative studies. Possible sampling bias was a concern across the majority of studies, due to self-selection and referral of participants.

All randomised control trials (RCTs) were assessed using the RoB2 tool (Higgins, Savović, Page, Elbers, & Sterne, 2019). The results of the RoB2 assessment can be found in Table 6. The quality assessment indicated a high risk of bias across all RCTs, and results from these studies should therefore be interpreted with caution. The risk of bias due to deviations from the intended interventions was a major issue across studies (Arjadi et al., 2018; Jones et al., 2014; Tighe et al., 2017), due to difficulties with sampling, blinding participants/practitioners or nonadherence to intervention regimen. For example, trials demonstrated higher rates of attrition in the DMHI group compared to the control (Arjadi et al., 2018), nonequivalent baseline characteristics across groups (Jones et al., 2014) and high noncompletion of all available activities in the DMHI (Tighe et al., 2017). Lack of adequate reporting was also an issue across studies, particularly in relation to allocation sequences, blinding and potential deviations from interventions.

Both quality assessments (QualSyst and RoB2) highlighted concerns regarding the methodological quality of one trial (Jones et al., 2014), especially around randomisation and blinding processes, sample size and controlling for confounding. The RoB2 assessment indicated a high risk of bias in this trial across all domains except the selection of reported results. These issues led to a lack of equivalence between groups, with notably higher levels of baseline child disruptive behaviours in the

intervention group, which precluded significance testing.

Characteristics of included studies

Research designs. The studies included four feasibility pilot studies (Chandra et al., 2014; Glover et al., 2019; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019; Shepherd et al., 2015), three RCTs (Arjadi et al., 2018; Jones et al., 2014; Tighe et al., 2017), two pre-/postcomparisons (Neal-Barnett et al., 2019; Tighe et al., 2020) and one case series analysis (Anton et al., 2016). Studies evaluated the DMHIs using a range and combination of methods, including standardised outcome measures, qualitative interviews and focus groups. Table 3 outlines the study and participant characteristics.

Study participants. The majority of studies focused on teenagers, up to a broad cut-off for the adolescence of 25 years old (Das et al., 2017; Seko, Kidd, Wiljer, & McKenzie, 2014), with average participant age of 16.89 years. Sample sizes ranged from 9 to 313 participants, with an average sample of 71.58 participants. The target population for each intervention varied widely. Studies focused on a range of communities experiencing socioeconomic marginalisation, including Aboriginal/Indigenous youth in New Zealand (Shepherd et al., 2015) and Australia (Tighe et al., 2017, 2020), homeless youth in the USA (Glover et al., 2019; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019), adolescent girls living in Bangalore's urban slums in India (Chandra et al., 2014), Black adolescent girls enrolled in free school meals programmes in the USA (Neal-Barnett et al., 2019), children of low-income families in the USA (Anton et al., 2016; Jones et al., 2014) and a community sample of youth living in less-economically developed areas in Indonesia (Arjadi et al., 2018).

Intervention characteristics. Overall, seven DMHIs were investigated across the 10 publications, described in Table 4. Mobile applications (apps) ($n = 5$) (Glover et al., 2019; Neal-Barnett et al., 2019; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019; Tighe et al., 2020, 2017) were the most common mode of technology used. Three interventions used 'traditional' phone features (Anton et al., 2016; Chandra et al., 2014; Jones et al., 2014) such as phone calls or SMS. Three DMHIs used smartphone features added to the primary delivery mode, such as predownloading other apps onto participants' phones or asking participants to record and upload videos (Anton et al., 2016; Jones et al., 2014; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019). One intervention was web-based (Arjadi et al., 2018) and one intervention was delivered as a computer game that did not require an internet connection (Shepherd et al., 2015). Only two DMHIs, investigated in four studies, provided technology to participants (Anton et al., 2016; Jones et al., 2014; Glover et al., 2019; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019).

The majority of DMHIs drew on established therapeutic models, such as CBT-based interventions (Shepherd et al., 2015; Tighe et al., 2017, 2020), behavioural interventions (Anton et al., 2016; Arjadi et al., 2018; Schueller et al., 2015) or cognitive

Table 4. DMHI characteristics

DMHI name	Population	Mental health outcomes	Technology	DMHI description	Additional features	Technology provision	Practitioner involvement
TE-HNC (Technology-enhanced helping the non-compliant child)	Low-income caregiver-child dyads meeting clinical cut-offs for ECBI behavioural difficulties	Behavioural Symptoms	Smart phone + video conferencing	Smartphone-based parenting programme delivered by therapists, aiming to teach child management strategies for disruptive behaviours	Daily surveys, skills development videos, video recording of skills practice, SMS reminders	Smartphones provided to participants	Videoconference therapy delivered by therapists
Guided Act and Feel Indonesia (GAF-ID)	Indonesian community sample of low-income and middle-income young people meeting clinical criteria for depression (MDD or PDD)	Depression, fear, social support, quality of life	Web based	Online behavioural activation compared to the control group (online minimal psychoeducation)	Lay counsellors provide technical assistance, feedback and reminders to complete modules	Technology not provided	Supported by lay counsellors who receive brief training but have no professional background in mental health
MOGGU	Adolescent girls living in the urban slums of Bangalore	Qualitative semi-structured interview about participants' experiences of the intervention in relation to their mental health	SMS based	Daily SMS-messaging intervention. Participants were advised to use the intervention whenever they felt sad, angry or depressed or felt-like talking to a counsellor. Daily messages alternated between mental health advice and helpline information	Participants could call or text any time for support	Technology not provided. 40% of participants had their own phone; 60% shared a phone with friends/family	Fully practitioner delivered
Pocket Helper & Pocket Helper 2.0	Homeless youth in Chicago	Trauma/PTSD, anxiety, depression, emotional regulation	Smartphone app	Smartphone app-based intervention, including an automated self-help system, with brief cognitive behavioural intervention and daily surveys assessing mood and advice regarding coping strategies	Various additional apps were preinstalled, focusing on behaviour change strategies, crisis hotlines, crowd-based emotional support tools and resources for homeless youth in Chicago	Smartphones were provided with 1 month of mobile data preloaded	No practitioner involvement

(continued)

Table 4. (continued)

DMHI name	Population	Mental health outcomes	Technology	DMHI description	Additional features	Technology provision	Practitioner involvement
Build Your Own Theme Song (BYOTS)	Black adolescent girls enrolled in federal-free school meal programme in the low-income school district	Anxiety	Smartphone app	The BYOTS mHealth app consists of creating a self-recorded theme song as part of a cognitive restructuring intervention	The app was used adjunct to in-person intervention (Sisters United Now)	Technology not provided	Fully supported by practitioners as part of Sisters United Now intervention
SPARX (Smart, Positive, Active, Realistic, X-factor thoughts)	Maori youth in New Zealand and their families	Depression, mood and anxiety	Online computer game	Culturally adapted online CBT-based computer game to help youth with mild to moderate depression, stress or anxiety	Aimed to teach CBT approaches for self-help	Technology not provided	No practitioner involvement was reported
iBobbly	Aboriginal and Torres Strait Islander youth	Suicidal ideation, depression, distress, impulsivity	Mobile app	Self-help app developed to reduce suicidal ideation. iBobbly uses an ACT framework, drawing on Indigenous cultural values	Additional safety checks to assess active suicidality were conducted twice during participation	Technology not provided	No practitioner involvement

Table 5. Quality appraisal of included studies

Item	Studies																						
	Anton et al. (2016)	Arijadi et al. (2018)	Chandra et al. (2014)	Glover et al. (2019)	Jones et al. (2014)	Neal-Barnett et al. (2019)	Schueller, Glover, et al. (2019); Schueller, Hunter, et al. (2019)	Shepherd et al. (2015)	Tighe et al. (2017)	Tighe et al. (2020)													
Quant.	2	2	2	2	2	2	2	2	2	2													
Quali.	2	2	1	2	2	1	2	2	2	2													
Element	Objective described	Study design appropriate	Strategy of sample selection appropriate	Participant characteristics described	Random allocation described	Blinding of investigators described	Blinding of participants described	Outcome measures defined and robust	Appropriate sample size	Appropriate analysis described	Variance estimates reported	Controlled for confounding	Results reported in sufficient detail	Conclusions supported by results	Clear context for the study	Connection to the theoretical framework	Data collection methods systematic	Data analysis is complete and systematic	Use of verification procedure(s)	Reflexivity of the account	Quantitative Summary Score	Qualitative Summary Score	
1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
2	2	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	N/A	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	1	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	N/A	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	N/A	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	2	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	N/A	2	2	1	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	N/A	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
11	N/A	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
12	N/A	2	2	1	0	N/A	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
13	2	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
14	1	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
9	1	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
8	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	86%	96%	55%	54%	46%	65%	75%	95%	82%	45%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Summary Score	Strong	Strong	Strong	Adequate	Adequate	Limited	Adequate – Good	Good	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong

2: full compliance to criteria, 1: partial compliance, 0: no compliance, N/A: not applicable.
 Summary scores: strong (>80%), good (70–80%), adequate (50–70%) and limited (<50%).

Table 6. Risk of bias assessment of RCTs

Item	Element	Arjadi et al. (2018)	Jones et al. (2014)	Tighe et al. (2017)
D1	Risk of bias from the randomisation process	Some concerns	High	Low
D2	Risk of bias from deviations from the intended intervention	High	High	High
D3	Missing outcome data	Low	High	Low
D4	Risk of bias in the measurement of outcome	Some concerns	High	Low
D5	Risk of bias in the selection of reported result	Low	Low	Low
Overall		High risk	High risk	High risk

restructuring (Neal-Barnett et al., 2019). Two DMHIs involved counselling via telephone or SMS (Arjadi et al., 2018; Chandra et al., 2014). One DMHI incorporated coping skills training (Glover et al., 2019; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019). One DMHI involved parenting programmes (Anton et al., 2016; Jones et al., 2014).

Measuring digital and socioeconomic marginalisation. A range of measures was used to quantify socioeconomic and digital marginalisation. The most common measure was household income, usually based on parental income (Anton et al., 2016; Arjadi et al., 2018; Chandra et al., 2014; Jones et al., 2014; Tighe et al., 2017). School-based measures were used internationally, including measures such as enrolment in free school meals programmes or attendance at educational institutions in low-income catchment areas (Chandra et al., 2014; Neal-Barnett et al., 2019). Other studies identified young people belonging to a marginalised group likely to experience digital inequalities, such as Aboriginal youth (Shepherd et al., 2015; Tighe et al., 2017, 2020) or homeless youth (Glover et al., 2019; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019). This was followed by area-based measures, such as indices of multiple deprivations or living in an urban slum (Chandra et al., 2014). Three studies used multiple socioeconomic measures, although none reported comparisons across these measures (Chandra et al., 2014; Neal-Barnett et al., 2019; Tighe et al., 2017). No studies directly measured digital connectivity.

Measuring mental health outcomes. The included interventions focused on a range of mental health issues, assessed using a variety of standardised and nonstandardised measures, thus making comparisons difficult. The main mental health areas of intervention were depression, anxiety and distress, described in Table 4. More than half of the DMHIs targeted depressive symptoms (Arjadi et al., 2018; Glover et al., 2019; Schueller et al., 2015; Shepherd et al., 2015; Tighe et al., 2017, 2020).

Four studies, reporting on three DMHIs, used the same outcome measure, the Patient Health Questionnaire (PHQ-9) for depressive symptoms (Arjadi et al., 2018; Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019; Tighe et al., 2017, 2020). Two DMHIs, reported in three studies, targeted anxiety, although none utilised the same measure (Glover et al., 2019; Neal-Barnett et al., 2019; Shepherd et al., 2015). The two studies that measured

psychological distress using the Kessler Psychological Distress Scale (K10) reported the same DMHI (Tighe et al., 2020, 2017). Half of the studies, reporting on four DMHIs, included qualitative nonstandardised measures of mental health issues (Chandra et al., 2014; Glover et al., 2019; Shepherd et al., 2015; Tighe et al., 2017, 2020).

Findings of the review

The findings from the included papers generated four overarching integrated themes: effectiveness, acceptability and feasibility. The synthesised qualitative and quantitative results are presented under each of the integrated themes.

Effectiveness. Studies evaluated the effectiveness of DMHIs for improving various mental health outcomes using a range and combination of methods, including quantifying standardised outcome measures, qualitative interviews and focus groups.

Four of the six studies that included pre-/postintervention comparisons demonstrated statistically significant improvements in depressive symptoms (Arjadi et al., 2018; Tighe et al., 2017), anxiety (Neal-Barnett et al., 2019) and externalising symptoms (Jones et al., 2014). The two studies that found no significant differences between baseline and postintervention outcomes nevertheless were supported by qualitative findings which indicated that participants found the interventions to be helpful in reducing distress and suicidality (Tighe et al., 2020) and found the coping skills learned in the intervention useful (Schueller, Glover, et al. 2019; Schueller, Hunter, et al., 2019; Tighe et al., 2020).

While all three included RCTs reported significant improvements in mental health outcomes postintervention compared to baseline (Arjadi et al., 2018; Jones et al., 2014; Tighe et al., 2017), only two were statistically significant compared to a control group ($p < .05$; Arjadi et al., 2018; Tighe et al., 2017). Only one study included the long-term follow-up, with significantly lower depressive symptoms at 3 months ($p = .021$) and 6 months ($p = .007$; Arjadi et al., 2018). Despite these significant findings, due to the high risk of bias across all three RCTs, caution is advised when interpreting these results.

Acceptability. Studies explored the acceptability of DMHIs through quantitative, qualitative and mixed methods, including preintervention codesign sessions, mid-intervention feedback and postintervention evaluations.

Qualitative and quantitative findings indicated that digital devices, and particularly smartphone apps, are acceptable and appropriate tools to deliver mental health interventions for these populations. In qualitative interviews and focus groups, participants reported positive feelings towards the use of these DMHIs (Arjadi et al., 2018), stating that the DMHIs were culturally appropriate (Neal-Barnett et al., 2019; Shepherd et al., 2015; Tighe et al., 2017, 2020), and realistic, in that they would use these DMHIs in real-world scenarios (Glover et al., 2019; Neal-Barnett et al., 2019).

Qualitative findings demonstrated conflicting reports regarding privacy, where some participants found the private nature of DMHIs helpful in overcoming stigma and reluctance to seek help in person (Tighe et al., 2020), whereas others cited privacy as a key concern, particularly for participants who shared devices between family members (Chandra et al., 2014).

Codesign efforts focused on the acceptability and appropriateness of each DMHI and relevant features. Of the seven DMHIs described in the 10 included studies, five interventions were fully codesigned with adolescents and developed in consultation together with the target service users (Chandra et al., 2014; Glover et al., 2019; Neal-Barnett et al., 2019; Schueller, Glover, et al., 2019; Schueller, Hunter, et al., 2019; Shepherd et al., 2015; Tighe et al., 2020, 2017). One DMHI was developed in consultation with other stakeholders without involving target service users (Anton et al., 2016; Jones et al., 2014). One DMHI provided no information about codesign (Arjadi et al., 2018). The studies with the highest engagement and adherence were fully codesigned together with target populations (Chandra et al., 2014; Tighe et al., 2017).

Feasibility. Studies investigated the feasibility of DMHIs through adherence and attrition rates, level of practitioner involvement and cost-effectiveness of the intervention, using primarily descriptive quantitative methods.

Adherence and attrition rates varied widely between studies. Two studies did not report attrition rates. Of these, one involved a longitudinal pre-/postcomparison (Neal-Barnett et al., 2019) and the other involved qualitative focus groups (Shepherd et al., 2015). Two studies reported very high adherence (>90%) with low attrition rates (Chandra et al., 2014; Tighe et al., 2017). Three studies reported 70–80% adherence rates, with under 30% of participants dropping out (Anton et al., 2016; Arjadi et al., 2018; Jones et al., 2014). The two studies with the highest attrition rates (40–50%) worked with homeless adolescents longitudinally (Glover et al., 2019; Schueller, Glover, et al., 2019; Schueller, Hunter, et al., 2019). Quality assessment raised concerns regarding attrition in two out of the three RCTs that could have affected trial outcomes, as Arjadi et al. (2018) reported substantially higher dropout rate in the experimental condition, and Jones et al. (2014) cited dropout reasons that may be related to the primary outcome of child disruptive behaviours (e.g. family stressors such as divorce).

Three of the seven DMHIs were practitioner-delivered (Anton et al., 2016; Chandra et al., 2014; Jones et al., 2014; Neal-Barnett et al., 2019). The majority ($n = 4$) were automated, although some included optional

practitioner involvement, through elective support or linking to external services (Arjadi et al., 2018; Glover et al., 2019; Schueller, Glover, et al., 2019; Schueller, Hunter, et al., 2019; Tighe et al., 2017), whereas others offered no practitioner involvement (Shepherd et al., 2015; Tighe et al., 2020).

Half of the studies cite cost-effectiveness as a benefit of the DMHI compared to face-to-face interventions (Anton et al., 2016; Arjadi et al., 2018; Chandra et al., 2014; Jones et al., 2014; Shepherd et al., 2015), however, only one study conducted cost-effectiveness analyses (Jones et al., 2014).

Discussion

This review aimed to appraise and synthesise the available evidence for the effectiveness of DMHIs for socioeconomically and digitally marginalised youth. Ten studies describing seven DMHIs were included in the review. While there is some evidence suggesting that digitally delivered interventions can be effective in improving mental health outcomes among the socioeconomically and digitally marginalised populations included in this review, more high-quality research is needed in order to determine whether DMHIs can fully bridge the so-called digital divide.

The DMHIs analysed here demonstrated some evidence for improving mental health outcomes among diverse digitally marginalised populations, however, it is unclear whether these findings would be generalisable beyond the populations included in this review. The limited quantity and quality of studies highlight the need for more high-quality research, particularly RCTs. Although not all studies included in this review demonstrated statistically significant improvements, qualitative findings demonstrated promising results regarding engagement, acceptability and feasibility of DMHIs for socioeconomically and digitally marginalised youth. Qualitative findings supported quantitative results across all the phenomena of interest, however, more research is necessary in order to explore these themes in greater depth.

While RCTs are widely considered the gold standard for evaluating psychological interventions (Cartwright, 2010), it is important to include both qualitative and quantitative research in evaluating DMHIs among marginalised populations, in terms of research design and inclusion criteria for reviews. Through this, it is possible to provide a more holistic understanding of marginalised young people's experiences using DMHIs that may not be captured through standardised measures. More research is nevertheless required to further determine the efficacy and acceptability of DMHIs among digitally marginalised children and youth. Previous reviews have confirmed the effectiveness of DMHIs for various marginalised adult populations, such as individuals experiencing homelessness (Heaslip, Richer, Simkhada, Dogan, & Green, 2021), indigenous communities (Li & Brar, 2022) and other underserved populations (Schueller, Glover, et al., 2019; Schueller, Hunter, et al., 2019). This present review further supports these findings and expands the evidence base for children and young people.

The majority of interventions were based on behavioural or cognitive behavioural therapeutic models. There is an established evidence base for CBT-based interventions among children and young people (Higgen,

Mueller, & Möske, 2021; Wright et al., 2019), with CBT widely adapted for digital delivery (Cervin & Lundgren, 2022; Ebert et al., 2015; Wickersham, Barack, Cross, & Downs, 2022) among children and young people (Christ et al., 2020; Ebert et al., 2015; Rooksby, Elouafkaoui, Humphris, Clarkson, & Freeman, 2015; Wickersham et al., 2022). There was huge variability between included studies, in terms of outcomes, technologies, participants and interventions. While this heterogeneity makes comparisons difficult, this suggests that DMHIs have the potential to work across various technologies for a variety of outcomes. Furthermore, the interventions included in this review functioned with differing degrees of practitioner involvement, suggesting that there are effective DMHIs with various levels of contact between practitioners and service users. This has implications for intervention delivery and development, as it may be possible to develop effective and cost-effective interventions that remove financial barriers while also alleviating pressure on face-to-face services.

While on one hand, digital approaches to mental healthcare have the potential to break down these barriers, on the other hand, these technologies have the potential to reproduce existing digital and social inequalities, thus marginalising such communities even further (Park, & Humphry, 2019). It remains unclear the extent to which socioeconomic and digital marginalisation has been taken into consideration in the development and implementation of DMHIs beyond those studies included in this review, and the unique challenges and concerns that these marginalised young people face. When implementing digital interventions, mental health services need to develop and adopt evidence-based digital inclusion strategies, in order to prevent further reinforcing the social inequalities already experienced among marginalised communities (Bucci et al., 2019; Robotham, Satkunanathan, Doughty, & Wykes, 2016).

All included interventions involved some level of co-design with target service users. Codesign ensures that interventions are fit-for-purpose, engaging and user-centred (Garrido et al., 2019; Grist, Porter, & Stallard, 2017). This is particularly important for marginalised populations, to ensure representation, cultural relevance, appropriateness and engagement among marginalised communities. Previous reviews of DMHIs among general populations have suggested that issues of high attrition, low engagement and lack of relevancy can be explained by a lack of codesign in development stages (Fullagar, Rich, Francombe-Webb, & Maturo, 2017; Grist et al., 2017; Lattie et al., 2019). While the studies included in this review saw varying rates of attrition, it is possible that dropout rates would have been substantially higher without such high levels of codesign.

The quality assessments highlighted some major concerns in the included studies, similar to other systematic reviews of DMHIs for broader populations of children and young people (Cervin & Lundgren, 2022; Christ et al., 2020). In particular, the risk of bias assessment of included RCTs drew attention to issues relating to sampling, attrition, awareness of assigned conditions and nonadherence to interventions. The scarcity and low quality of available research into DMHIs for socioeconomically and digitally marginalised youth limits the

conclusions that may be drawn from this review. Previous research, however, has questioned the appropriateness and highlighted the challenges of applying stringent quality assessments beyond the context of the RCT (Higgen et al., 2021; Thomson, Craig, Hilton-Boon, Campbell, & Katikireddi, 2018), cautioning that over-reliance on quality assessments may potentially impede research progress in emerging research contexts.

Limitations

Due to the limited number of included trials and heterogeneity among outcomes, methodologies, populations and DMHI characteristics, a meta-analytic approach was deemed inappropriate for the current review. The quality and variability of included studies limited potential comparisons and conclusions. The inclusion criteria limited this review to digitally and socioeconomically marginalised populations, leading to the exclusion of DMHIs for general youth populations. The generalisability of broader reviews of youth-centred DMHIs for the population targeted in this review remains unclear and vice versa (Stiles-Shields et al., 2022). As this review only included studies found in selected databases, written in English, there was potential selection and language bias. This review, however, involved searching the grey literature and included studies with non-significant results, therefore reducing the risk of potential publication bias. As this review focuses on populations likely to experience socioeconomic and digital inequalities, and the intersection of these inequalities, this paper cannot speak to the generalisability of these findings to other marginalised groups.

Implications

Digital inequalities and the so-called 'digital divide' cannot be an afterthought within mental health research if DMHIs are to truly bridge the digital divide. An intersectional and multidisciplinary approach is needed to understand how these inequalities play out within the digital mental health landscape. DMHIs, and digital mental health research more broadly, require digital inclusion by (co)design, otherwise, this will lead to the digital exclusion by default.

Conclusion

This systematic review fills a gap in the literature by investigating digitally delivered interventions, utilising a range of technologies, to improve mental health outcomes among digitally and socioeconomically marginalised youth. While the evidence base is not yet well established, DMHIs appear to be a promising option for meeting the mental health needs of these populations. Further research is needed to fully determine whether DMHIs can truly bridge the 'digital divide' as a viable option for intervention and service provision.

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Ethical information

No ethical approval was required for this review article.

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