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Digital Mental Health Interventions for University Students With Mental Health Difficulties: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: While third-level educational institutions have long provided counselling, a sharp rise in demand has led to limited access to mental health supports for many students, including those with ongoing difficulties. Digital mental health interventions represent one response to this unmet need, given the potential low cost and scalability associated with no-to-low human resources involved.

Objective: The aim of this study was to conduct a systematic review and meta-analysis of the literature examining effectiveness of digital mental health interventions for university students with ongoing mental health difficulties.

Methods: The following databases were searched: PubMed, EBSCOhost (CINHAHL/PsycINFO/PsycArticles) and Web of Science. Two-armed randomised-control trials were included in the meta-analysis. A random-effects meta-analysis was conducted and standardised mean differences were calculated. Effect sizes were then compared in terms of therapeutic approach, and whether interventions were fully automated or guided interventions. This study was registered with PROSPERO, CRD42024504265.

Results: Thirty four eligible studies were included in this narrative synthesis, of which 21 randomised-controlled trials were included in the meta-analysis. Random-effects meta-analysis indicated an overall medium effect size in favour of digital interventions for both depression (Cohen's $d = 0.55$), and anxiety (Cohen's $d = 0.46$). Of note, for anxiety outcomes, fully automated interventions appeared more effective ($d = 0.55$) than guided interventions ($d = 0.35$).

Conclusions: Digital mental health interventions are associated with beneficial effects for college students when measured in terms of anxiety and depression symptom severity. For anxiety, fully automated interventions may be more effective than guided interventions to reduce symptom severity.

1 | Introduction

Mental health difficulties represent a growing global burden with up to 60% of young people meet the criteria for a diagnosis of depression and/or anxiety at any given point during their young adulthood (McGorry et al. 2024). The rising incidence of mental health difficulties in young people have consequently been described as representing a "dangerous phase" and an ignored risk factor for age-related medical illness later in life (McGorry et al. 2024). Rates of mental health difficulties among young people have risen substantially in the last decade, representing a 78% increase in 2017 compared to 2008 (Twenge

et al. 2019). Studies conducted in the US report that since the COVID-19 pandemic, approximately 75% of young people have reported worsening mental health (Bell et al. 2023). These changes are reflected in multiple indicators, including perceived poor mental health (Wiens et al. 2020), anxiety disorders (Goodwin et al. 2020), and depression (Goodwin et al. 2022). Given that approximately 63% of mental health problems are established by the age of 25 (Solmi et al. 2022), early intervention for mental health difficulties in young adulthood is important and has potential to yield significant benefits across the lifespan (Kessler et al. 2005; D'Adamo et al. 2023). In western countries, a majority of 18–25-year-old attend some form of third level education; for example, the OECD (2022) estimate that an average of 54% attend some form of third level, siding to 59% in the EU22. By taking action long before mental health problems worsen or by preventing their onset (Colizzi, Lasalvia, and Ruggeri 2020), early intervention has the potential to avoid significant burden among college students including academic failure, interpersonal problems and substance abuse (King et al. 2021).

For young adults, the college years are particularly important as they can involve multiple social and academic stressors such as academic demands, financial worries, and loneliness, which increases the risk for mental health difficulties (Duffy et al. 2019; Campbell et al. 2022). Further, emerging adulthood, which coincides with transition to college, represents the peak period of risk for the onset of mental health problems (Kessler et al. 2007; Duffy et al. 2020). According to a 2017 WHO study of approximately 14000 students from across eight countries, approximately one in three screened positive for at least one common DSM-IV anxiety, mood, or substance disorder. Previous evidence shows that 25% of university students experience depression and 14% experience suicide related outcomes (Auerbach et al. 2018). Similarly, a longitudinal study by Duffy et al. (2020) revealed that one-third of first-year undergraduate students endorse clinically significant depressive and anxiety symptoms at entry to university.

Rates of mental health service utilisation among college students have also increased considerably (Lipson, Lattie, and Eisenberg 2019; Oswalt et al. 2020; Osborn et al. 2022). For example, in 2017, 94% of universities in the UK reported an increase in demand for counselling services compared to the prior five years (Thorley 2017; Worsley, Pennington, and Corcoran 2022). Similarly, a study in the US by Oswalt et al. (2020) using national data reported an increase of 4.3% in service utilisation among college students between 2009 and 2015. This has been challenging for students' mental health services, in terms of service provision and financing, resulting in longer waiting times (Walsh et al. 2022) and only short-term interventions being made available with the consequent risk of not being able to provide quality treatment (Hallett 2012; Harrison and Gordon 2021).

In response to this high demand for mental health services among college students, there is a growing interest in the use of digital mental health interventions (DMHIs). DMHIs are digitally delivered interventions which may be based on well-established psychological treatments (Gan et al. 2021). DMHIs have the potential to offer a scalable, cost-effective, and accessible solution to increase access to mental health services and reduce burden on college service delivery systems (Lipson, Lattie, and Eisenberg 2019; Schueller and Torous 2020; Ha and Kim 2020), as they are capable of being directly accessible to people with no-to-low human resources, at any time of the day at the point of need, and have the potential to promote self-management of mental health problems (Andersson and Titov 2014; Gan et al. 2021). Moreover, previous research on self-help interventions for depressive symptoms and anxiety disorders on adult populations has shown promising results, suggesting that the effectiveness of these interventions is similar to in-person mental health treatment (van't Hof, Cuijpers, and Stein 2009; Cuijpers et al. 2010; Leung et al. 2022).

1.1 | Guided Versus Fully Automated Digital Interventions

Digital interventions have been sub-categorised as either interventions that are fully digitally based/automated or interventions with some level of human support/guidance, e.g. from a therapist or peer. The later have been variously termed as 'guided' digital interventions (Pineda et al. 2023) or 'blended' digital interventions (Erbe et al. 2017; Valentine et al. 2020). In this study, we refer to the former as 'fully automated' interventions and the later as 'guided' interventions. Guided interventions can be further sub-categorised into asynchronous therapy, where there is a delay between responses (e.g., emails and text), and synchronous therapy, which refers to methods where providers and clients communicate at the same time, such as a phone call or a video conference (Philippe et al. 2022).

This distinction between guided and fully automated digital interventions may be important in terms of level of engagement and adherence (Lattie et al. 2019). Forbes et al. (2023) defined adherence as "the actual digital intervention use compared with intended use" and engagement as "to which extent patients interact with an intervention." Moreover, study attrition refers to "failure to complete the research protocol associated with an online intervention" (Linardon and Fuller-Tyszkiewicz 2020). A wide range of engagement rates (26% and 100%; Stanic et al. 2021; Winter et al. 2022), and attrition rates (23%–64%; Linardon and Fuller-Tyszkiewicz 2020) have been reported for digital interventions. A systematic review by Borghouts et al. (2021) suggested that interventions that include some levels of prompting were associated with improved adherence but appeared agnostic about whether this needed to come from another human or was simply an automated reminder. By comparison, research on traditional mental health care has suggested that human guidance is an important factor that increases intervention efficacy and therefore intervention engagement (Ebert et al. 2018; Musiat et al. 2022).

A number of psychological theories have provided suggestions as to why human support or guidance may be important for adherence. For example, the therapeutic alliance is suggested to benefit outcomes because of a collaborative agreement between therapist and client on the goals of the treatment, the tasks, and the development of a personal bond (Ardito and Rabellino 2011). By comparison, the supportive-accountability model (Mohr, Cuijpers, and Lehman 2011) proposes that adherence to online interventions increases when human support is provided on account of a sense of accountability to a coach that is seen as trustworthy. However, mixed results have been reported on the influence of support in DMHIs, especially among college

students, as some studies such as Harrer et al. (2018) reported that support did not affect intervention effectiveness, whereas others such as Conley et al. (2016) concluded that support yielded greater effects. Some of the reasons for this may be that the effectiveness of human support varies across populations and based on the characteristics (e.g., training level) of the support provider, which may explain the variability of these results (Werntz et al. 2023). Moreover, Harrer et al. (2018) proposed that for university students, there may be other factors that are more important than the provision of guidance but more research is needed to determine what these factors may be. The relevance of these hypothesised factors need to be evaluated in order to better understand the relationship between engagement and level of automaticity/guidance for college students (Harith et al. 2022).

1.2 | Therapeutic Approach and Mode of Delivery

Other relevant factors in understanding young people's engagement with digital mental health interventions include the therapeutic approach and the mode of delivery. In terms of therapeutic approach, cognitive behavioural therapy (CBT) represents the leading therapeutic approach among DMHIs (Balcombe and De Leo 2022). Recent studies have demonstrated the positive effects of internet-based CBT (iCBT) in reducing mental health symptoms among college students (McCall et al. 2018). Acceptance and commitment therapy (ACT) has also been adopted for online treatment (Levin, Hicks, and Krafft 2022) and has been found to effectively treat mental health issues such as anxiety and depression among university students (Hemmings et al. 2021). Modes of delivery may include mobile applications (apps), virtual or augmented-reality, web-based interventions, chatbots or conversational agents to name a few. A systematic overview by Lehtimaki et al. (2021) found that computerised CBT was effective at alleviating symptoms of depression and anxiety in young people, whereas the effectiveness of other DMHIs such as therapeutic video games or mobile apps remained inconclusive.

1.3 | The Present Study

Considering the rapid growth of DMHIs and the high prevalence of mental health difficulties among university students, further systematic examination of the existing literature is needed, as evidence suggests that engagement with DMHIs among college students is low (Melcher et al. 2022; D'Adamo et al. 2023), and students in need of care may not be reached or do not utilise these treatment tools (Fleming et al. 2018). Moreover, although previous reviews have focused on the effectiveness of DMHIs among university students (D'Adamo et al. 2023; Montagni et al. 2020; Riboldi et al. 2023) there seems to be a gap of knowledge in terms of systematic reviews of DMHIs among clinical and sub-clinical college student populations. Students are exposed to a large variety of stressors, which increases their level of anxiety and stress, and therefore the risk of developing mental health difficulties. Thus, the current systematic review and meta-analysis aims to (a) estimate the effectiveness of DMHIs directed at university students that already present with mental health difficulties, and (b) to determine if guided interventions are more effective than fully automated ones. We expect to find that DMHIs will be effective for university students with mental health difficulties and that for both anxiety and depressive outcomes, guided interventions will be more effective than fully automated ones.

2 | Methods

The reporting of the present systematic review was based on the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA; Page et al. 2021). A protocol of the present review was previously registered in PROSPERO (February 3, 2024; CRD42024504265) (Figure 1).

2.1 | Inclusion Criteria

The Population, Intervention, Comparator, Outcome, and Study design (PICOS) framework (McKenzie et al. 2019) was used to guide inclusion criteria eligibility.

In terms of population (1), only studies that included university students with mental health difficulties, by inclusion of assessment (i.e., GAD-7, PHQ-9), were included. Studies of adolescents, children or young people that are not enrolled in a third-level institution were excluded. University students had to be in the 18–25 age range to be eligible. Eligible interventions (2) included any studies that used a digital mental health intervention based on standardised psychological interventions, such as CBT, mindfulness, ACT, etc. All types of digital tools were included. In terms of comparator (3), eligible studies included those employing usual care or control groups that received no intervention, or an alternative intervention. Studies that employed a waiting list were also included. Studies reporting any type of mental health outcome measure (4) were included. Finally, (5) peer-reviewed English language feasibility studies, randomised controlled trials, non-randomised controlled trials, other types of randomised trials, longitudinal studies, and mixed methods pilot, published in the last 6 years were included in this review.

2.2 | Search Strategy

A scoping of the literature was conducted by using Google Scholar and PubMed to identify the types of available studies for synthesis. Moreover, results from a parallel scoping review revealed that the vast majority of research on digital mental health interventions for university students was conducted since 2018 onwards. Therefore, to ensure that our study reports on the most up to date literature, we decided to include studies that were conducted in the last 6 years. As a follow up, we conducted a search in February 2024 of the following databases: PubMed, EBSCOhost (CINHAHL/PsycINFO/PsycArticles), and Web of Science using the keywords and search terms presented in Table 1. Searches were limited to English language peer-reviewed articles published from 2018 to 2024.

2.3 | Selection Process

A three-step approach was used to evaluate studies according to the selection criteria. First, all records were imported to

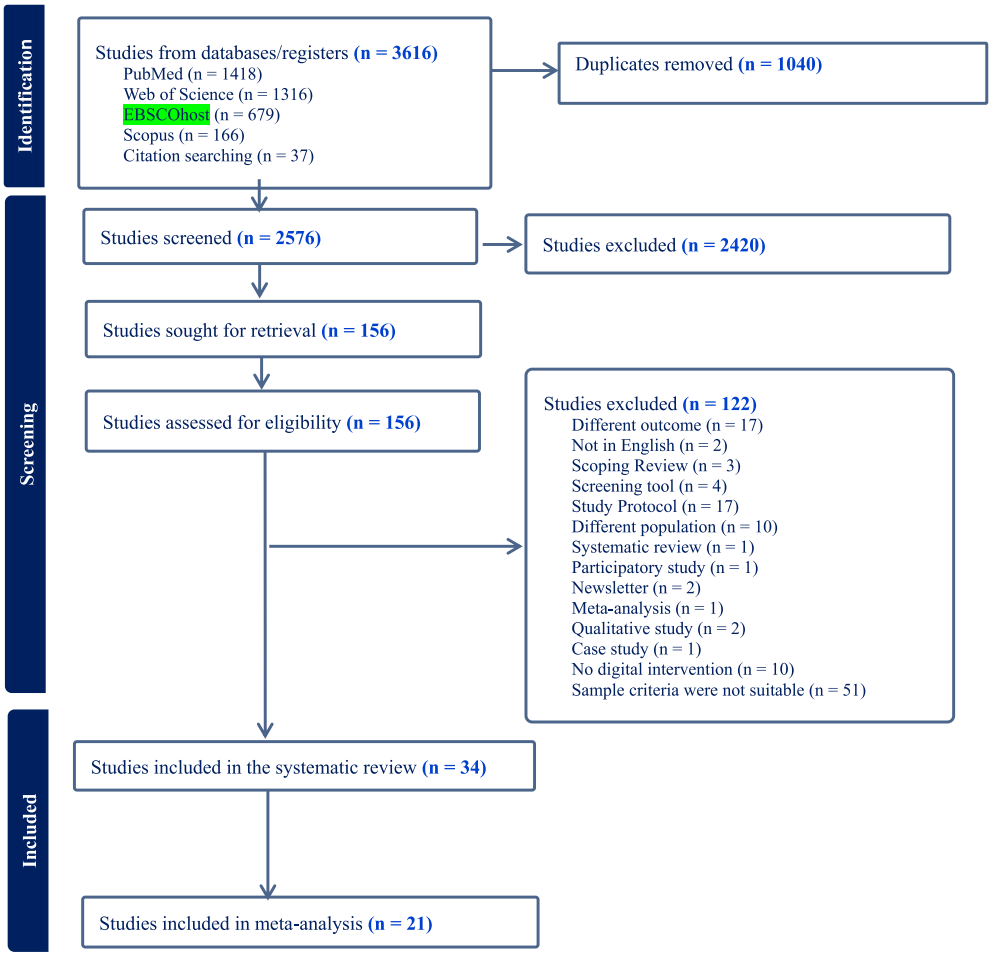

FIGURE 1 | PRISMA flow diagram.

TABLE 1 | Keywords and search terms used in the systematic review.

1	(“Mental health issues” OR “mental health problems” OR “mental illness” OR “mental problems” OR “mental disorders” OR “mental health disorders” OR “psychiatric diagnosis” OR “psychiatric disorder”) AND
2	(“University students” OR “college students” OR “third-level students” OR “undergraduate students” OR “postgraduate students” OR students OR “graduate students” OR “first-year students” OR “second-year students” OR “third-year students” OR “fourth-year students” OR “final-year students”) AND
3	(Interventions OR program* OR therap* OR implementation OR evaluation OR develop*) AND
4	(“digital interventions” or “Computer Assisted Therapy” or “Online Therapy” or Mhealth or Ehealth or M-Health or E-Health or “M Health” or “E Health” or Web-based or “Web based” or Internet-based or “Internet based” or App or Application or “Mobile phone” or Text or SMS or Computer* or “artificial intelligence” or AI or online or Virtual or Cyber or Interactive or Digital Technolog* or “conversational user interface” or “chatbot*”)

Covidence (Veritas Health Innovation 2020), where duplicates were removed. In the second stage, title and abstract screening was conducted by at least 2 of the 3 reviewers for agreement (A.M., C.K., C.P.) and full-text articles were retrieved. In the third stage, the full-text articles were screened for eligibility (A.M., C.K., C.P.). Differences between the reviewers were resolved by consensus.

2.4 | Data Extraction

Details about the DMHI used in each study were extracted independently by two reviewers (A.M. and C.K.). Relevant information included study design, age, and participant characteristics. We also included details about the measurements used as eligibility criteria reported in the studies to justify

the presence of mental health difficulties (e.g., He et al. 2022: "average score of the depression subscale in the College Students Mental Health Screening Scale (CSMHSS) within 2 to 3"). Discrepancies were resolved by consensus (A.M. and G.D.).

2.5 | Quality Assessment

To assess for risk of bias, two reviewers (A.M. and C.K.) conducted the assessments independent. The reviewers used the Cochrane Risk of Bias Tool (version 1) for Randomised Controlled Trials (Higgins et al. 2011). Regarding non-randomised studies, the Risk of Bias in Non-Randomised Studies of Interventions (ROBINS-I) tool (Sterne et al. 2016) was used. Assessment of risk of bias based was judged as low/high/unclear risk of bias based on each of the criteria.

2.6 | Meta-Analysis

Eligibility criteria for the meta-analysis included studies with a two-armed RCT that reported anxiety and depression outcomes. Two studies (Hides et al. 2019; Six et al. 2022) were excluded from the meta-analysis as these did not have available outcome data. The Comprehensive Meta-Analysis Software package (CMA, version 4; Borenstein et al. 2013) was used to conduct the analysis, based on a random effects model.

Two analyses of effectiveness were conducted: the first focused on DMHIs that reported outcomes for severity of anxiety symptoms (Salamanca-Sanabria et al. 2020; Harrer et al. 2018; Karyotaki et al. 2022; Ponzo et al. 2020; Papini et al. 2023; O'Bryan et al. 2021; Sun et al. 2022; Suffoletto et al. 2021; McCall et al. 2018; Bautista et al. 2022; Short and Schmidt 2020; Newman et al. 2021; Levin, Hicks, and Krafft 2022; Dumarkaite et al. 2022); the second focused on DMHIs that reported outcomes for depressive symptom severity (Salamanca-Sanabria et al. 2020; Bruhns et al. 2021; Harrer et al. 2018; Karyotaki et al. 2022; Kim and Lee 2023; Ponzo et al. 2020; Zhao et al. 2022; Kingston et al. 2020; Sun et al. 2022; Suffoletto et al. 2021; Ruehlman and Karoly 2023; Newman et al. 2021; Levin, Hicks, and Krafft 2022; Räsänen, Muotka, and Lappalainen 2023; Dumarkaite et al. 2022).

Between-groups standardised mean differences (SMD) were calculated and used as effect sizes. Sensitivity analyses were performed to examine robustness of the overall findings. The Q statistic was used to assess study heterogeneity (Borenstein et al. 2009). The I^2 statistic was also calculated to estimate the percentage of variance in the observed effects owing to the variance in true effects; with $I^2 \geq 75\%$ indicating considerable heterogeneity (Higgins et al. 2003).

Subgroup analyses were also performed to ascertain the effect of level of guidance on effectiveness of interventions. Finally, publication bias was examined by visual examination of funnel plots and the trim-and-fill method (Duval and Tweedie 2000).

3 | Results

3.1 | Search and Selection

A total of 3616 references were imported into Covidence for initial abstract screening. After removing duplicates, the titles, and abstracts of 2576 studies were screened and 2420 studies were excluded as not meeting inclusion criteria. A total of 156 studies were then assessed for full-text eligibility screening, resulting in 34 studies that met the inclusion criteria; 21 of these studies had 2-armed RCTs that could be included in the meta-analysis.

3.2 | Study Characteristics

Table 2 summarises the characteristics of included studies. In terms of study location, 13 (38%) of the studies were conducted in the *United States* (Haeger, Davis, and Levin 2022; Thomas et al. 2023; Palacios et al. 2018; Attridge et al. 2020; Six et al. 2022; Papini et al. 2023; Newman et al. 2021; Short and Schmidt 2020; Ruehlman and Karoly 2023; O'Bryan et al. 2021; Bautista et al. 2022; Rackoff et al. 2022; Suffoletto et al. 2021; Levin, Hicks, and Krafft 2022); 4 (12%) in the *United Kingdom* (Cook, Mostazir, and Watkins 2019; Ponzo et al. 2020; Broglia, Millings, and Barkham 2019; Kingston et al. 2020) and *China* (Sit et al. 2022; He et al. 2022; Zhao et al. 2022; Sun et al. 2022); 3 (9%) in *Germany* (Hennemann et al. 2022; Harrer et al. 2018; Bruhns et al. 2021); 2 (6%) in *Australia* (Dear et al. 2019; Hides et al. 2019); 1 (3%) in *Canada* (McCall et al. 2018), *Republic of Korea* (Kim and Lee 2023), *Colombia* (Salamanca-Sanabria et al. 2020), the *Netherlands* (Karyotaki et al. 2022), *Lithuania* (Dumarkaite et al. 2022), *Finland* (Räsänen, Muotka, and Lappalainen 2023), *India* (Newman et al. 2021), and *Pakistan* (Akram and Arshad 2022). A total of 6234 participants were included in this systematic review. Sample size ranged from 11 (Haeger, Davis, and Levin 2022) to 1080 (Dear et al. 2019); and participants' mean age ranged from 18.53 to 25 (mean = 21.21, SD = 3.03). Regarding study design, 74% (25/34) of studies were *RCTs* (Räsänen, Muotka, and Lappalainen 2023; Cook, Mostazir, and Watkins 2019; He et al. 2022; Six et al. 2022; Salamanca-Sanabria et al. 2020; Harrer et al. 2018; Karyotaki et al. 2022; Kim and Lee 2023; Papini et al. 2023; Newman et al. 2021; Short and Schmidt 2020; McCall et al. 2018; Ruehlman and Karoly 2023; O'Bryan et al. 2021; Bautista et al. 2022; Zhao et al. 2022; Ponzo et al. 2020; Rackoff et al. 2022; Bruhns et al. 2021; Suffoletto et al. 2021; Sun et al. 2022; Levin, Hicks, and Krafft 2022; Dumarkaite et al. 2022; Kingston et al. 2020; Hides et al. 2019), 9% (3/34) were *within groups pre-post trials* (Haeger, Davis, and Levin 2022; Sit et al. 2022; Akram and Arshad 2022); 6% (2/34) were *non-randomised trials* (Palacios et al. 2018; Broglia, Millings, and Barkham 2019); and the remaining papers included a *longitudinal study* (Attridge et al. 2020), an *exploratively secondary analysis* (Hennemann et al. 2022), *a prospective study* (Dear et al. 2019), and a *micro-randomised trial* (Thomas et al. 2023). Of note, out of the 25 RCTs, 16 (64%) used a waitlist control (Räsänen, Muotka, and Lappalainen 2023; Salamanca-Sanabria et al. 2020; Harrer et al. 2018; Kim and Lee 2023; Papini et al. 2023; Newman

TABLE 2 | Summary of the 34 studies included in the systematic review.

Study and country	Total *N*	Mean age (SD)	Sample mental health criteria	Study design	Control	Psychological treatment	Duration	Mental health measures	Human support	Main findings
1. Haeger, Davis, and Levin (2022) USA	11	23.55 (5.11)	Eligibility criteria included placement on the CCC waiting list with at least 2 weeks before their first scheduled face-to-face therapy appointment, and having a presenting problem of depression and/or anxiety. The study did not actively screen participants for depression and anxiety, and instead relied on the CCC clinician's discretion to provide materials to individuals with these presenting problems.	A pre-post, open trial design	Not Applicable	ACT	8 weeks	DASS—Depression, Anxiety and Stress AAQ-II—Psychological inflexibility CFQ—Cognitive fusion PHLMS—Mindfulness VQ-valued living ESAS—Emotional self-awareness	No	Participants improved on depression and anxiety symptoms as well as psychological inflexibility processes.
2. Thomas et al. (2023) USA	35	18.53 (0.53)	First-generation status students (parents had not completed a 4-year college degree) had to report distress on 4 or more or the las 7 days that interfered with functioning.	Micro-randomised trial (MRT)	Yes, no intervention	ACT	2 weeks	PHQ-2—Depression PSS-4—Perceived Stress	No	The intervention increased values-based behaviour but did not decrease avoidance behaviour. The intervention reduced depressive symptoms but not perceived stress.
3. Räsänen, Muotka, and Lappalainen (2023) Finland	123	25 (4.52)	To be eligible, students had to report experiencing some form of psychological distress, such as stress, low mood, and/or anxiety.	2-armed RCT	Yes, waitlist	ACT	8 sessions (1 per week)	MHC-SF—Subjective psychological, emotional, and social well-being PSS-10—Perceived Stress PHQ-9—Depression	Yes	ACT-based, blended internet interventions with semi-structured coach feedback and minimally tailored features can be as effective as interventions with fully personalised feedback.
4. Sit et al. (2022) China	39	18.9 (0.94)	Students were included if they had a score of Patient Health Questionnaire-9 (PHQ-9) of 10 or higher	An uncontrolled, single-armed pilot trial	Not Applicable	BAT	6 weeks; 3-, and 6-month follow-up	PHQ-9—Depression GAD-7—Anxiety WHO-5—Anxiety and well-being PSYCHOLOPS—Stress	Yes	Significant decrease of depression, anxiety, and self-defined problems.
5. Palacios et al. (2018) USA	102	N/A	Students had to meet the threshold for mild depression (score of 5+ on the PHQ-9), anxiety (5+ on the GAD-7), or stress (15+ on the DASS-21 stress subscale, after multiplying score by 2)	Non-Randomised Trial of acceptability, effectiveness, and satisfaction	Not Applicable	CBT	7 weeks; 3-month follow-up	PHQ-9—Depression GAD-7—Anxiety DASS-21—Stress	Yes	Significant decrease in depression, anxiety, and stress.

(Continues)

TABLE 2 | (Continued)

Study and country	Total *N*	Mean age (SD)	Sample mental health criteria	Study design	Control	Psychological treatment	Duration	Mental health measures	Human support	Main findings
6. Cook, Mostazir, and Watkins (2019) UK	235	20.41 (1.5)	Students had to score above the 75th percentile on at least one measure of worry/rumination: ≥ 50 on the Penn State Worry Questionnaire (PSWQ); ≥ 40 on the Ruminative Response Scale (RRS)	3-armed RCT	Yes, waitlist	CBT	6 weeks	PSWQ—Worry PHQ-9—Depression GAD-7—Anxiety RRS—Rumination	Yes	Significant improvements in rumination, worry, and depressive symptoms.
7. Hennemann et al. (2022) Germany	149	24.60 (5.16)	Eligibility criteria included students with elevated somatic symptom distress, as indicated by a score ≥ 4 on the Patient Health Questionnaire, somatic symptom scale (PHQ-15)	Exploratively secondary analysis of a two armed, group RCT	Yes, waitlist	CBT	3-,6-15-months follow-up	PHQ-15—Somatic symptoms of distress SSD-12—Adverse psycho-behavioural symptoms of the somatic symptom disorder PHQ-9—Depression GAD-7—Anxiety PDI—Functional disability	Yes	Internet-delivered cognitive behavioural therapy with regular guidance is not unequivocally superior to guidance-on-demand
8. Dear et al. (2019) Australia	1080	23	Students who presented to the CAPS, and self-reported symptoms of stress, anxiety, low mood, or depression and wanted psychological treatment.	A large, prospective, single-group Phase-IV clinical trial	Not Applicable	CBT	8 weeks	PHQ-9—Depression GAD-7—Anxiety	Yes	Large clinical reductions in symptoms of both anxiety and depression were observed.
9. He et al. (2022) China	148	18.78 (0.89)	College students with an average score of the depression subscale in the College Students Mental Health Screening Scale (CSMHSS) within 2 to 3.	A single-blind, 3-armed randomised controlled trial	Yes, active control	CBT	8 sessions (twice per week) 1 month.	PHQ-9—Depression	Yes	Significant reductions in depression.
10. Attridge et al. (2020) USA	951	23.79 (6.93)	Users had to be from a customer of Learn to Live in the higher education market segment (i.e., a college or university). Users were required to be at a sufficient level of clinical severity (clinical status) at the start of program use	Longitudinal, repeated measures research design	Not Applicable	CBT	5 weeks; 3-month follow-up	PHQ-9—Depression GAD-7—Anxiety SPIN—Social Anxiety MOS—Insomnia	Yes	Significant improvements for stress, anxiety, worry, and insomnia.
11. Six et al. (2022) USA	94	20.77 (2.54)	Students having a score of five or higher on the PHQ-8	2-armed RCT	Yes, active control	CBT	4-months	PHQ-8—Depression GAD-7—Anxiety PSS-10—Stress PANAS—Positive and Negative Affect	No	These results indicate that CBT mental health apps, such as AirHeart, have the potential to reduce depressive symptoms over a short intervention period

(Continues)

TABLE 2 | (Continued)

Study and country	Total *N*	Mean age (SD)	Sample mental health criteria	Study design	Control	Psychological treatment	Duration	Mental health measures	Human support	Main findings
12. Salamanca-Sanabria et al. (2020) Colombia	150	22.15 (4.74)	College students with mild to moderately severe depressive symptoms determined by the Patient Health Questionnaire—9 scores of 10–19	2-armed RCT	Yes, waitlist	CBT	5 sessions	PHQ-9—Depression GAD-7—Anxiety	Yes	Significant effects for depression and anxiety
13. Harrer et al. (2018) Germany	150	24.1 (4.1)	University students with elevated levels of perceived stress (PSS-4 ≥ 8)	2-armed RCT	Yes, waitlist	CBT	8 weeks	PSS-4—Perceived Stress CES-D—Depression STAI—State Anxiety WHO-5—General well-being MBI—Emotional Exhaustion	Yes	Significant effects for stress, depression, anxiety, well-being, and emotional exhaustion.
14. Karyotaki et al. (2022) Netherlands	100	21.91 (2.61)	College students with mild to moderate symptoms of depression defined by scoring above the cut-off score of 4 on the Patient Health Questionnaire (PHQ-9) and/or anxiety symptoms as defining by scoring above the cut-off score of 4 on the Generalised Anxiety Disorder scale—7 items (GAD-7).	2-armed RCT	Yes, active control	CBT	8 weeks; 3-month follow-up	PHQ-9—Depression GAD-7—Anxiety	Yes	No evidence of a difference between the intervention and the control.
15. Kim and Lee (2023) Republic of Korea	34	N/A	The participants had to be female college students with a traumatic experience and posttraumatic stress symptom scores of 22–66, which is a cutoff that can be diagnosed as PTSD; anything above 66 is a severe PTSD condition that cannot be suitably addressed in this study	2-armed RCT	Yes, waitlist	CBT	7 weekly sessions +4 weeks boost session.	SLESQ—Traumatic experiences IES-R—Post-traumatic stress CES-D—Depression Functional Health Pattern Assessment Screening Tool	Yes	The program reduced post-traumatic stress and depression symptoms and improved functional health and adjustment.
16. Papini et al. (2023) USA	159	19.72 (1.42)	Students were invited to participate in this study if they had high anxiety sensitivity, defined as an ASI-3 total score greater than 22	2-armed RCT	Yes, waitlist	CBT	2-months follow-up	SSAI—Anxiety Sensitivity	No	Significant mean reduction in anxiety.
17. Newman et al. (2021) India	222	19.90 (1.56)	Students met criteria for clinical or subthreshold GAD	2-armed RCT	Yes, waitlist	CBT	6 sessions in 3-months; 6-month follow-up	GAD-Q-IV—Anxiety PSWQ—Worry DASS-D—Depression	Yes	Significant reductions in GAD severity, worry, and depressive symptoms

(Continues)

TABLE 2 | (Continued)

Study and country	Total *N*	Mean age (SD)	Sample mental health criteria	Study design	Control	Psychological treatment	Duration	Mental health measures	Human support	Main findings
18. Short and Schmidt (2020) USA	61	19.43 (2.04)	Students were invited to participate if they completed a screening survey, and scored at least 1 SD above the sample mean on abbreviated anxiety (Penn State Worry Questionnaire), and insomnia (Insomnia Severity Index)	2-armed RCT	Yes, active control	CBT	6-, and 12-month follow-up	SAS—Safety aids related to various anxiety disorders. SRBQ—Insomnia-related safety behaviours ISI—Severity of insomnia PSWQ—Worry BAI—Anxiety DOCS—Obsessive compulsive PCL-5—PTSD	No	Findings suggest that targeting safety aids for anxiety and insomnia is acceptable and effective in reducing the target mechanism, safety aids, as well as worry.
19. McCall et al. (2018) Canada	101	21.86 (5.50)	Students that were experiencing some degree of social anxiety.	2-armed RCT	Yes waitlist	CBT	Single session; 1-month follow-up	SIAS-6—Social anxiety FNE—Negative evaluation Q-LES-Q-SF—Quality of life, enjoyment, and satisfaction	No	Significant reduction in social anxiety.
20. Ruehlman and Karoly (2023) USA	68	19.42 (1.84)	Students with symptoms of depression, assessed using the PHQ-8	2-armed RCT	Yes, waitlist	CBT	1 week; 1-monht follow up	PHQ-8—Depression CD-Quest—Cognitive distortions	No	Significant lower levels of depression.
21. O'Bryan et al. (2021) USA	68	19.68	Students who reported elevated levels of health anxiety as determined by a SHAI score at least 1 SD above the student mean; and that reported elevated AS as determined by an ASI-3 score falling at least 1 SD above the nonclinical mean	2-armed RCT	Yes, placebo	CBT	Single session, 2-week follow-up	ASI-3—Anxiety sensitivity SHAI—Health anxiety	No	Individuals in the active condition exhibited greater reductions in AS compared to the control condition.
22. Bautista et al. (2022) USA	35	21.86 (4.82)	Students with a score of 6 or higher on the Mini Social Phobia Inventory (Mini-SPIN)	2-armed RCT	Yes, waitlist	CBT	7weeks; 3-month follow-up	SIAS-6—Social anxiety	Yes	Significant rate of decline in social anxiety scores over time.
23. Zhao et al. (2022) China	182	21.75 (1.33)	Students with depressive symptoms, according to the Beck Depression Inventory-II, and a semi-structured interview.	2-armed RCT	Yes, waitlist	CBT + ACT	3years	BDI-II—Depressive symptoms MHC-SF—Positive mental health	No	Significant reductions in depressive symptoms and improvement in positive mental health.
24. Ponzo et al. (2020) UK	262	19.87 (1.79)	Students that scored > 14 points on the Depression, Anxiety and Stress Scale-21 items (DASS-21) stress subscale or > 7 points on the DASS-21 anxiety subscale	2-armed RCT	Yes, waitlist	CBT + BAT	7weeks	STAI-S-6—State anxiety DASS-21—Anxiety, stress, and depression WEMWBS—Perceived well-being	No	Significant reductions in anxiety and increased perceived well-being.

(Continues)

TABLE 2 | (Continued)

Study and country	Total *N*	Mean age (SD)	Sample mental health criteria	Study design	Control	Psychological treatment	Duration	Mental health measures	Human support	Main findings
25. Broglia, Millings, and Barkham (2019) UK	38	22 (3.67)	Help-seeking students who had been accepted for counselling and met moderate clinical criteria on one of two standardised outcome measures for anxiety or depression.	2-armed, nonrandomized design	Yes, active control	CBT + Mindfulness	Single session, 1-week follow-up, and 1-month follow-up.	PHQ-9—Depression GAD-7—Anxiety CORE-10—changes in general psychological functioning. CCAPS-62—changes in mental health	Yes	No significant differences
26. Rackoff et al. (2022) USA	585	20.44 (4.50)	Students who reported moderate or higher stress during the COVID-19 pandemic	2-armed RCT	Yes, active control	CBT + PA	2 weeks	DASS-21—stress, anxiety, and depression	No	No significant changes in stress and depression.
27. Bruhns et al. (2021) Germany	523	22.95 (3.35)	Students having depressive symptoms measured by the PHQ-9.	2-armed RCT	Yes, waitlist	CBT + PA + DBT	6 weeks; 3-momth follow-up	PHQ-9—depression RSE—self-esteem WHOWOL-BREF—quality of life	No	Significant reduction in depressive symptoms and a significant increase in self-esteem.
28. Suffoletto et al. (2021) USA	52	18.7 (0.45)	Inclusion criteria: current mental health diagnosis documented in their electronic medical record or received mental health services within 3 months per self-, parent-, or clinician-report, graduated high school, plan to attend college or higher education within 6 weeks.	2-armed RCT	Yes, active control	CBT + PA + DBT	4 weeks; 6-week follow-up	MHSES—Mental health self-efficacy CCAPS—psychological symptoms	No	Reductions in mental health symptoms over time and significant between-group effects.
29. Sun et al. (2022) China	114	N/A	Students experiencing elevated psychological distress, such that their depression or anxiety symptoms at or above the mild cutoff on the Patient Health Questionnaire-9 (PHQ-9) and the 7-item Generalised Anxiety Disorder Scale (GAD-7)	2-armed RCT	Yes, active control	Mindfulness	1-monht; 3-monht follow-up	GAD-7—Anxiety PHQ-9—Depression MAAS—dispositional mindfulness MSPSS—perceived social support	Yes	Both mindfulness and social support, delivered via mHealth, show promise in reducing distress and addressing anxiety.
30. Levin, Hicks, and Krafft (2022) USA	23	20.43 (2.46)	Students on the waitlist for the Counselling and Psychological Services centre, currently seeking treatment at CAPS with an expected wait time of at least 2 weeks for services	2-armed RCT	Yes, waitlist	Mindfulness	3-months	CCAPS-34—psychological symptoms MHC-SF—positive mental health	No	Very preliminary support was found for potential app efficacy relative to the control condition, particularly for depression, anxiety, and overall distress.
31. Dumarkaite et al. (2022) Lithuania	70	23.31 (3.11)	Students who met the clinical significance criteria for PTSD, CPTSD, or disturbances in self-organisation symptoms with or without functional impairment as measured with the International Trauma Questionnaire	2-armed RCT	Yes, waitlist	Mindfulness	8 sessions (1 per day) Intervention access for 3 months	LEC-5—Traumatic events ITQ—Symptoms of PTSD and CPTSD	Yes	Significant changes in CPTSD scores between groups.

(Continues)

TABLE 2 | (Continued)

Study and country	Total *N*	Mean age (SD)	Sample mental health criteria	Study design	Control	Psychological treatment	Duration	Mental health measures	Human support	Main findings
32. Kingston et al. (2020) UK	206	23.4 (6.53)	Students with elevated levels of depressive symptoms (DASS-D; ≥ 10)	2-armed RCT	Yes, active control	Mindfulness	4 weeks	DASS-D-21—Depression	No	Significant reductions in depression.
33. Akram and Arshad (2022) Pakistan	20	20 (1.5)	The inclusion of these participants was determined based on whether or not they obtained moderate (scores between 52 and 60) or high (scores 61 or above) scores on the Toronto Alexithymia Scale (TAS-20)	A pilot quasi-experimental study	Yes, waitlist	Other (Alexithymia reduction treatment, ART)	4 sessions (1 per week)	TAS-20—Alexithymia MHSQ—presence of psychological disorders or physical disabilities SCL-R—symptoms of common psychological disorders	No	The statistical analysis showed a significant reduction in the participants' alexithymia, as well as depression and anxiety.
34. Hides et al. (2019) Australia	169	19.2 (2.5)	Students who reported mild distress in the past month on the Kessler 10 Psychological Distress scale (K10 > 17)	2-armed RCT	Yes, waitlist	Other (Dynamic info-motivation-behavioural skills health behaviour model)	4 weeks; 2-month follow-up	DERS-SF—Emotion dysregulation K10—psychological distress MHC-SF—mental well-being	No	Lack of significant differences between groups.

Abbreviations: ACT, acceptance and commitment therapy; BAT, behavioural activation; CBT, cognitive-behavioural therapy; DBT, dialectical behaviour therapy; PA, positive psychology.

et al. 2021; McCall et al. 2018; Hides et al. 2019; Ruehlman and Karoly 2023; Bautista et al. 2022; Zhao et al. 2022; Ponzo et al. 2020; Bruhns et al. 2021; Levin, Hicks, and Krafft 2022; Akram and Arshad 2022; Dumarkaite et al. 2022), 8 (32%) used an active control (He et al. 2022; Six et al. 2022; Karyotaki et al. 2022; Short and Schmidt 2020; Rackoff et al. 2022; Suffoletto et al. 2021; Sun et al. 2022; Kingston et al. 2020), and 1 (4%) used a placebo control (O'Bryan et al. 2021).

Table S3 (Supporting Information) provides an overview of the sample characteristics. It is important to highlight that only four studies (Karyotaki et al. 2022; Broglia, Millings, and Barkham 2019; Palacios et al. 2018; Kingston et al. 2020) provided details about the inclusion of international students in their sample, and only six studies (Salamanca-Sanabria et al. 2020; Bruhns et al. 2021; Harrer et al. 2018; Räsänen, Muotka, and Lappalainen 2023) provided details about the field of study of their sample. Therefore, it was difficult to draw conclusions on the impact of these factors on the effect of the interventions.

3.3 | Types of Intervention

Regarding the focus of the interventions, 53% (18/34) of the studies were based on *CBT only* (Palacios et al. 2018; Cook, Mostazir, and Watkins 2019; Hennemann et al. 2022; Dear et al. 2019; He et al. 2022; Attridge et al. 2020; Six et al. 2022; Salamanca-Sanabria et al. 2020; Harrer et al. 2018; Karyotaki et al. 2022; Kim and Lee 2023; Papini et al. 2023; Newman et al. 2021; Short and Schmidt 2020; McCall et al. 2018; Ruehlman and Karoly 2023; O'Bryan et al. 2021; Bautista et al. 2022); 18% (6/34) were based on a *multicomponent treatment* (Zhao et al. 2022; Ponzo et al. 2020; Broglia, Millings, and Barkham 2019; Rackoff et al. 2022; Bruhns et al. 2021; Suffoletto et al. 2021); 12% (4/34) were based on *mindfulness* (Sun et al. 2022; Levin, Hicks, and Krafft 2022; Dumarkaite et al. 2022; Kingston et al. 2020); 9% (3/34) were based on *ACT* (Akram and Arshad 2022; Hides et al. 2019); 6% (2/34) were based on *other types of treatment* (Akram and Arshad 2022; Hides et al. 2019); and one study (3%) was based on *behavioural activation (BAT)* (Sit et al. 2022). Digital interventions were designed to address a range of mental health symptoms, including depression, anxiety, and stress. The included studies used either the Beck Depression Inventory (Beck, Ward, and Mendelson 1961; Beck, Steer, and Brown 1996), the Centre for Epidemiological Studies Depression Scale (Radloff 1977), the Patient Health Questionnaire (Kroenke et al. 1998, 2009; Kroenke, Spitzer, and Williams 2001) or the Depression, Anxiety and Stress Scale (Lovibond and Lovibond 1995) as outcomes measures of depressive symptoms. Moreover, the Generalised Anxiety Disorder scale (Spitzer et al. 2006), the Beck Anxiety Inventory (Beck et al. 1988), and the Depression, Anxiety and Stress Scale (Lovibond and Lovibond 1995) were used as outcomes measures of anxiety symptoms.

3.4 | Type of Support

Half (17/34) of the studies were based on *guided* DMHIs that included some level of human support (Räsänen, Muotka, and

Lappalainen 2023; Sit et al. 2022; Palacios et al. 2018; Cook, Mostazir, and Watkins 2019; Hennemann et al. 2022; Dear et al. 2019; He et al. 2022; Attridge et al. 2020; Salamanca-Sanabria et al. 2020; Harrer et al. 2018; Karyotaki et al. 2022; Kim and Lee 2023; Newman et al. 2021; Bautista et al. 2022; Broglia, Millings, and Barkham 2019; Sun et al. 2022; Dumarkaite et al. 2022) and the other half (17/34) were based on *fully automated* DMHIs (Haeger, Davis, and Levin 2022; Thomas et al. 2023; Six et al. 2022; Papini et al. 2023; Short and Schmidt 2020; McCall et al. 2018; Ruehlman and Karoly 2023; O'Bryan et al. 2021; Zhao et al. 2022; Ponzo et al. 2020; Rackoff et al. 2022; Bruhns et al. 2021; Suffoletto et al. 2021; Levin, Hicks, and Krafft 2022; Kingston et al. 2020; Akram and Arshad 2022; Hides et al. 2019).

Table S4 (Supporting Information) provides an overview of the support provided in the nine guided interventions included in the meta-analysis. Six studies (67%) reported that the support was provided by a postgraduate level student in Psychology (Räsänen, Muotka, and Lappalainen 2023; Salamanca-Sanabria et al. 2020; Harrer et al. 2018; Karyotaki et al. 2022; Sun et al. 2022; Dumarkaite et al. 2022), 1 (11%) by a trained rational emotive behaviour therapy counsellor (Kim and Lee 2023), one (11%) by trained clinicians in Psychology (Newman et al. 2021), and one (11%) by a peer-support worker (Bautista et al. 2022). Moreover, the support provided was generally asynchronous and provided online. Finally, it is important to highlight that the studies included in this review that were based on guided interventions reported mixed results in terms of whether human guidance increased adherence to the digital interventions (see Table S4).

3.5 | Meta-Analysis of Effectiveness

Of the 34 studies included in our review, 21 (62%) reported data that could be included in the meta-analysis. Of these, six studies (28%) reported depression outcomes only (Räsänen, Muotka, and Lappalainen 2023; Kim and Lee 2023; Bruhns et al. 2021; Kingston et al. 2020; Ruehlman and Karoly 2023; Zhao et al. 2022), nine studies (43%) reported both anxiety and depression outcomes (Suffoletto et al. 2021; Ponzo et al. 2020; Rackoff et al. 2022; Levin, Hicks, and Krafft 2022; Newman et al. 2021; Dumarkaite et al. 2022; Karyotaki et al. 2022; Harrer et al. 2018), and six studies (29%) reported anxiety outcomes only (Bautista et al. 2022; Papini et al. 2023; McCall et al. 2018; O'Bryan et al. 2021; Short and Schmidt 2020; Sun et al. 2022). No evidence of publication bias was observed throughout the studies (see Supporting Information).

3.5.1 | Depression

The aggregate effect of treatment on depression, as displayed on Figure 2, $d = 0.55$, suggested a medium effect size across the studies included ($k = 16$; $n = 2316$; Cohen's $d = 0.55$, 95% CI 0.37–0.72; $p < 0.001$). There was evidence of significant heterogeneity ($Q_{15} = 54.71$; $p < 0.001$; $I^2 = 72.58$; $T^2 = 0.08$; $t = 0.23$), which may be explained due to differences in the digital interventions that were used; including length, intervention type (i.e., blended or self-help), and psychological treatment (i.e., CBT, ACT, multicomponent). Additionally, there were differences in the measurements of outcomes (i.e., PHQ-9, DASS-D, CCAPS, BDI-II) (Cordero and Dans 2021).

3.5.2 | Anxiety

The aggregate effect of treatment on anxiety, as displayed on Figure 3, $d = 0.46$, suggested a medium effect size across the studies included ($k = 15$; $n = 1848$; Cohen's $d = 0.46$, 95% CI 0.31–0.61; $p < 0.001$). There was also evidence of significant heterogeneity ($Q_{14} = 28.16$; $p = 0.001$; $I^2 = 5.28$; $T^2 = 0.04$; $t = 0.20$), which can be explained due to differences in the type of interventions, delivery type, psychological treatment, and measurements of outcomes (i.e., GAD-7, BAI, DASS-21).

3.6 | Subgroup Analyses

Subgroup analyses were conducted for both anxiety and depression to examine whether the treatment effect differed across psychological treatment (see Table 3) and intervention type (see Table 4). For depression, the largest effect size was observed for CBT ($k = 6$; Cohen's $d = 0.69$, 95% CI 0.37–1.02, $p < 0.001$), followed by mindfulness ($k = 4$; Cohen's $d = 0.55$, 95% CI 0.34–0.75, $p < 0.001$), and multicomponent interventions ($k = 5$; Cohen's $d = 0.46$, 95% CI 0.01–0.83, $p = 0.013$). Guided interventions ($k = 8$; Cohen's $d = 0.56$, 95% CI 0.32–0.80, $p < 0.001$) appeared to be slightly more effective than fully automated interventions ($k = 8$; Cohen's $d = 0.53$, 95% CI 0.26–0.80, $p < 0.001$).

In regard to the studies that focused on anxiety, subgroups analyses revealed that CBT was also the most effective ($k = 9$; Cohens' $d = 0.53$, 95% CI 0.23–0.76, $p < 0.01$), followed by mindfulness ($k = 4$; Cohens' $d = 0.50$, 95% CI 0.02–0.98, $p = 0.04$), and multicomponent interventions ($k = 3$; Cohens' $d = 0.43$, 95% CI 0.03–0.57, $p < 0.001$). For anxiety, contrary to our hypotheses, larger effect sizes were observed for fully automated interventions ($k = 8$; Cohen's $d = 0.55$, 95% CI 0.35–0.61, $p = 0.002$) compared to guided interventions ($k = 7$; Cohen's $d = 0.35$, 95% CI 0.13–0.58, $p < 0.001$).

3.7 | Risk of Bias

In relation to the study design, 76% (26/34) of studies were RCTs and were rated according to the RoB-1 (Higgins et al. 2011), and 24% (8/34) were non-randomised controlled trials and were rated according to the ROBINS-I (Sterne et al. 2016). As shown in Figure 4, overall, 46% (12/26) of studies were rated on the RoB-1 with "some concerns" (22, 6, 31, 34, 30, 17, 21, 16, 26, 20, 19, 23) in relation to risk of bias; 31% (8/26) were rated with "low risk" (24, 27, 13, 9, 14, 15, 3, 28); and 23% (6/26) were rated with "high risk" (32, 19, 12, 11, 29, 2). Performance bias was the most prevalent domain of concern, followed by attrition bias resulting from unblinding of participants and self-report measures. A total of 24% (3/34) of non-RCTs were rated using the Risk of Bias in Non-Randomised Studies of Interventions (ROBINS-I) tool; 71% (5/7) of the studies were rated with "moderate risk" (33, 10, 25, 1, 7), and 29% (2/7) were rated with "low risk" (8, 5).

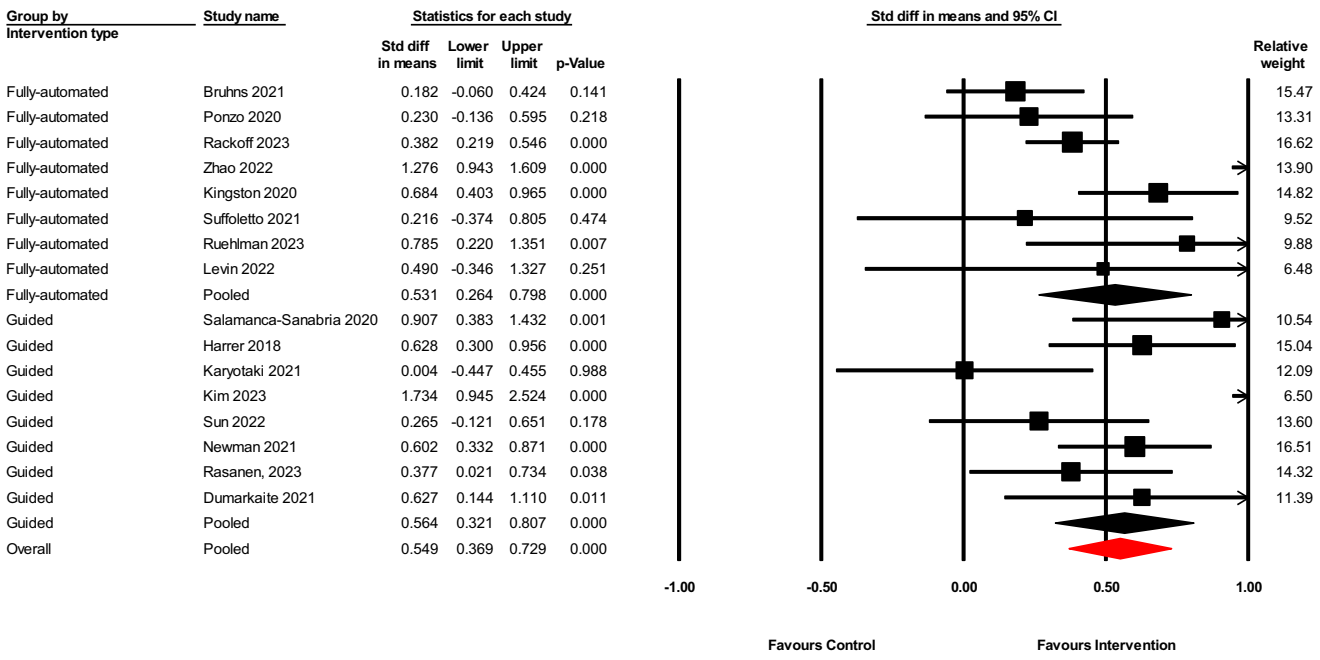

FIGURE 2 | Forest plot of summary statistics (SMD—Cohen's *d*) for digital interventions targeting depression among university students.

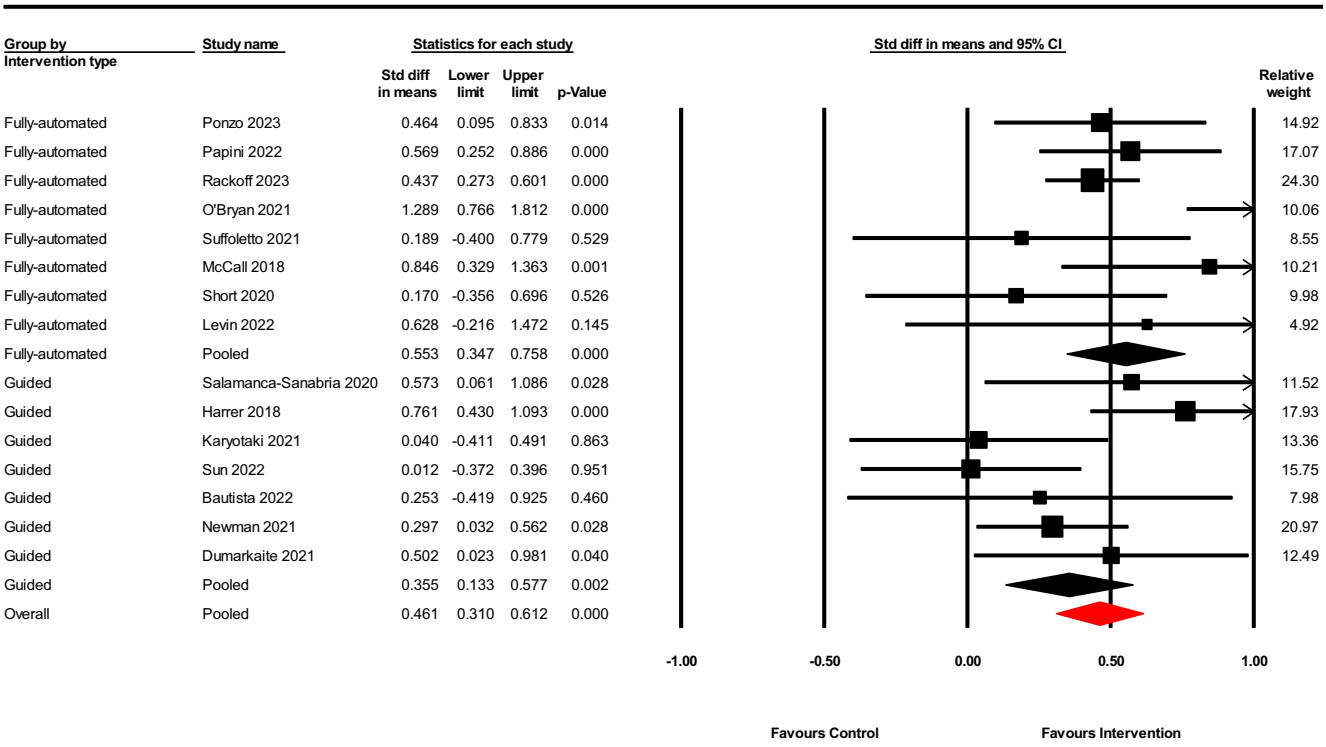

FIGURE 3 | Forest plot of summary statistics (SMD—Cohen's d) for digital interventions targeting anxiety among university students.

4 | Discussion

4.1 | Summary of Findings

This systematic review and meta-analysis aimed to synthesise the published literature on the effectiveness of digital mental health interventions for university students with mental health difficulties. While previous reviews had focused on non-clinical student populations (i.e., Harrer et al. 2018; Lattie et al. 2019; D'Adamo et al. 2023) this study focused specifically on mental health symptoms as measured by standardised psychological measures such as the GAD-7 and the PHQ-9. We hypothesised

TABLE 3 | Subgroup analysis of digital mental health interventions based on type of psychological treatment compared to controls.

	Number of studies ($n = 20$)	Cohen's d (95% CI)	p
Depression ($n = 15$)			
CBT	6	0.69 (0.33–1.72)	< 0.001
Mindfulness	4	0.55 (0.07–1.02)	< 0.001
Multicomponent	5	0.46 (0.01–0.83)	0.01
Anxiety ($n = 15$)			
CBT	9	0.53 (0.23–0.77)	< 0.001
Mindfulness	3	0.23 (0.09–0.67)	0.13
Multicomponent	3	0.43 (0.28–0.57)	< 0.001

Note: Two separate meta-analysis were conducted; one for depressive outcomes ($n = 16$), and one for anxiety outcomes ($n = 15$); of which $n = 11$ studies reported both anxiety and depressive outcomes, $n = 6$ reported depressive outcomes only, and $n = 5$ reported anxiety outcomes only. Subgroup analyses were conducted with $n = 20$ studies for type of psychological treatment. One study based on ACT (Räsänen, Muotka, and Lappalainen 2023) was excluded as it disrupted the even distribution of studies in each category.

TABLE 4 | Subgroup analysis of digital mental health interventions based on type of intervention compared to controls.

	Number of Studies ($n = 21$)	Cohen's d (95% CI)	p
Depression ($n = 16$)			
Guided interventions	8	0.56 (0.32–0.80)	< 0.001
Fully automated	8	0.53 (0.26–0.80)	< 0.001
Anxiety ($n = 15$)			
Guided interventions	7	0.35 (0.13–0.58)	0.002
Fully automated	8	0.55 (0.35–0.61)	< 0.001

Note: Two separate meta-analysis were conducted; one for depressive outcomes ($n = 16$), and one for anxiety outcomes ($n = 15$); of which $n = 11$ studies reported both anxiety and depressive outcomes, $n = 6$ reported depressive outcomes only, and $n = 5$ reported anxiety outcomes only. Subgroup analyses were conducted with $n = 21$ studies for intervention type.

that DMHIs would be effective for university students with ongoing mental health difficulties, and that interventions incorporating human interventions would be more effective than fully automated interventions.

Overall, in terms of efficacy and size of effect, our results suggested significant, medium-sized benefits of DMHIs when measured in terms of either depressive symptom severity or anxious symptom severity in participating students. These beneficial effects are consistent with past systematic reviews and meta-analyses. For example, Lattie et al. (2019) conducted a systematic review that aimed to synthesise the literature on the effectiveness, usability, acceptability, uptake and adoption of DMHIs for anxiety and depression, and enhancing well-being among university students. These authors reported that these interventions were effective in producing beneficial changes in the psychological outcome variables measured. In terms of meta-analyses, Ferrari et al. (2022) found small-to-moderate effects in favour to DMHIs on improving psychological wellbeing in university students. However, our review extends these previous findings by focusing on changes in severity of symptoms of depression and anxiety among college students, as well as providing evidence of the effectiveness of human support on these interventions. More recent reviews such as D'Adamo et al. (2023) have focused on examining reach and uptake of DMHIs based on CBT for college students. Our study expands this literature by focusing on the effectiveness of these interventions for college students with mental health difficulties, as well as not limiting the inclusion of the studies to those that included interventions based on CBT.

Finally, results from our sub-group analyses further suggested that the effectiveness of these interventions varied in terms of the presence or absence of human guidance, and in terms of the type of psychological treatment behind the intervention (CBT, mindfulness, etc.).

4.2 | The Role of Human Guidance

In terms of depressive symptom severity, the presence of human guidance was observed to significantly influence the size of the effect observed, which aligns with the results of previous meta-analytic reviews on digital interventions in the treatment of depression (Richards and Richardson 2012; Moshe et al. 2021). These reviews focused mostly on adult populations, however, our study focused on the potential of human guidance in digital interventions to improve depression symptom severity for university students with mental health difficulties.

Contrary to our hypothesis, when considering symptom severity in anxiety, we observed a somewhat higher overall effect size for fully automated interventions ($d = 0.55$) compared to guided interventions ($d = 0.35$). A recent meta-analysis by Pauley et al. (2023) reported no differences between guided and unguided interventions in the treatment of anxiety disorders for adult samples. These differing findings may reflect differences in the study population, and the amount and type of guidance provided.

Regarding why 1:1 human guidance appeared to be more important to outcome when measured in terms of depressive symptom severity rather than anxiety symptom severity, in the absence of an a priori hypothesis we can only speculate about why this was observed. For example, motivation could be one factor that explains why our results suggest a benefit for human guidance in symptoms of depression severity compared to anxiety severity

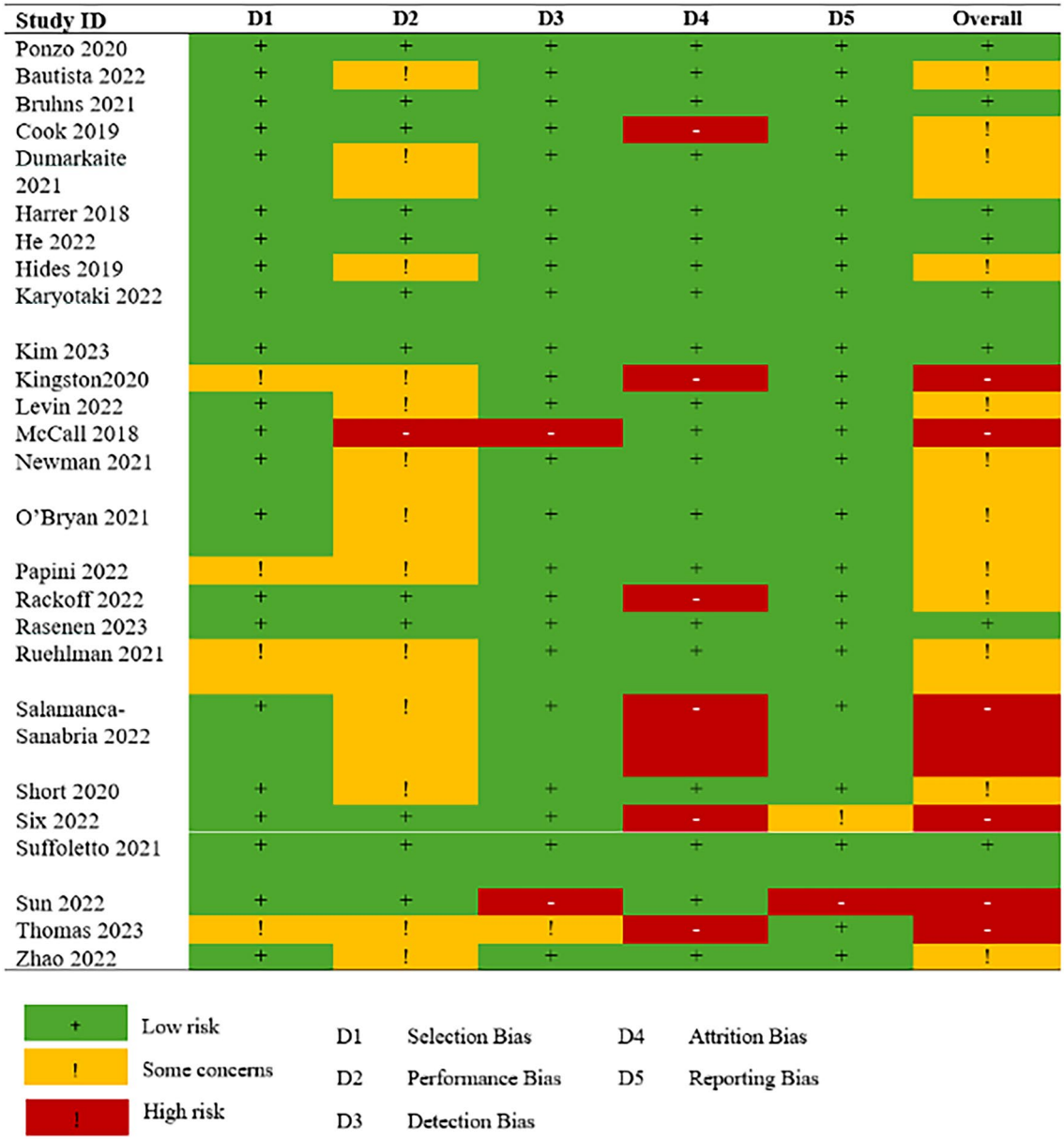

FIGURE 4 | Risk of bias assessment using the Cochrane risk of bias tool (version 1) for RCTs.

for university students with mental health difficulties. It has been suggested that motivation acts as a moderator of the effect of accountability; more specifically, the more intrinsically motivated clients are, the less support they require (Mohr, Cuijpers, and Lehman 2011). In this context, the self-determination theory (Ryan and Deci 2000) differentiates between intrinsic motivation, referring to doing something because it is inherently interesting, and extrinsic motivation, which refers to doing something because it leads to an external outcome. Clinically, individuals experiencing anxiety related difficulties may have higher intrinsic motivation (Winch, Moberly, and Dickson 2015) than individuals experiencing higher levels of depressive symptoms given that lower motivation and a need for extrinsic motivation (e.g., the support of others) is a clinical feature often associated with this group (Ling et al. 2016). Human support as part of a DMHI may provide a therapeutic alliance that increases extrinsic motivation, explaining why this group might benefit more from the human guidance component. This hypothesis will be important to test in future studies, particularly given the well-established overlap in anxious and depressive symptom presentation in many individuals.

It is important to note that the majority of guided interventions included in this study were provided by graduate psychology students instead of trained clinicians. Although previous reviews (Leung et al. 2022; Werntz et al. 2023) have reported no significant differences for clinician versus non-clinician guidance on DMHIs, there are important limitations that need to be considered. Firstly, the authors of previous reviews have highlighted the lack of detail available regarding the level of training or background of the individuals' providing support, limiting their ability to draw conclusions about the actual role of training of support providers on the efficacy of human support for DMHIs. Moreover, these reviews were not limited to college student samples; it is likely that the benefits of human guidance may well vary in terms of sample characteristics and outcome.

We speculate that for the studies included in this review, which focused specifically on university students with mental health difficulties, engaging non-clinicians in digital interventions may have represented a risk for the quality of support provided and the effectiveness of digital interventions. Again, future studies will benefit from an examination of the influence of clinically versus non-clinically trained guidance in digital mental health interventions for university students with mental health difficulties. It is also important to note that our results might not guarantee maintenance of treatment gains. Therefore, future research should address this issue in order to guarantee the value of these DMHIs as an alternative to traditional face to face interventions (perhaps for students presenting with mild symptom severity), or for students who are either waiting to start 1:1 intervention or who have completed a brief 1:1 psychological intervention and are seeking to sustain their recovery.

4.3 | Type of Psychological Interventions

Unsurprisingly, CBT-based interventions were the most widely reported (similar to the literature on traditional 1:1 psychological interventions). CBT-based interventions also appeared to be the most effective for reducing severity of symptoms of depression and anxiety when compared to other psychological therapies such as mindfulness. This evidence is in line with an umbrella review that synthesised evidence on digital health interventions targeting university students, which indicated that computer-based CBT was one of the factors associated with effectiveness (Harith et al. 2022). CBT is a widely used intervention modality that aims to identify maladaptive patterns of thinking, emotional responses, or behaviour and replace these with more adaptive responses (Lehtimaki et al. 2021). Several reviews have identified that most digital interventions focus on evaluating CBT (Lattie et al. 2019; Lattie, Stiles-Shields, and Graham 2022; Lehtimaki et al. 2021), while other interventions such as mindfulness, acceptance and commitment therapy (ACT), or interpersonal therapy remain somewhat under-evaluated. In line with these reviews, further studies of other digital psychological interventions are needed to confirm whether CBT-based interventions are in fact more effective than these other modalities.

4.4 | Limitations

Our work has some limitations. First of all, we note the heterogeneity in digital interventions including length, intervention type, psychological treatment, and differences in the measurements of outcomes. Our search strategy was not limited to RCTs and the inclusion of multiple trial designs is likely to have led to higher heterogeneity of the data included. However, we performed sub-groups analyses to examine the sources of heterogeneity. Secondly, the majority of studies included in this review were based on CBT (53%), which may have impacted the favourable effects of this treatment in comparison with other psychological treatments, as these appeared to be under-represented. Thus, the results of this review should be interpreted with caution. Finally, for the meta-analysis, we could not extract data from 13 studies, due to a lack of available outcome data, which made the pool of data of included studies smaller.

Overall, the existing studies included in this review focused only on mental health symptom severity. It is not clear how long participants had been struggling with these mental health difficulties and whether students had entered university with these symptoms or developed them during college. This lack of evidence concerning the longevity of mental health symptoms among college students is a notable gap in current datasets. Similarly, symptom severity is not the same as a clinically confirmed diagnosis, which typically was not reported in these studies, preventing us from drawing specific conclusions about illness subtypes.

4.5 | Conclusions

Digital mental health interventions have the potential to improve the mental health of university students that present with mental health difficulties. To date, the majority of research on DMHIs has focused on non-clinical populations rather than on clinical interventions that can be integrated with the counselling services in third-level institutions. This review demonstrates that DMHIs are an effective approach to improve the mental health of university students with mental health difficulties. The findings suggests that while human guidance may be beneficial when targeting depressive symptom severity, fully automated interventions may be sufficient to achieve a reduction in symptom severity. These results are encouraging, as designing interventions that require minimal clinical guidance or support can increase the accessibility and cost efficiency of digital interventions for students experiencing anxiety. Moreover, this review further supports the integration of guidance in digital interventions aimed at improving depression.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.