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The efficacy of self-guided internet and mobile-based interventions for preventing anxiety and depression – A systematic review and meta-analysis

Daniel Edge *, Edward R. Watkins, Jenny Limond, Jane Mugadza

Mood Disorders Centre, School of Psychology, University of Exeter, United Kingdom

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ABSTRACT

Background: Anxiety and depression are highly prevalent mental disorders which are associated with a considerable personal and economic burden. As treatment alone has a minimal impact on prevalence, there is now a growing focus on interventions which may help prevent anxiety and depression. Internet and mobile based interventions have been identified as a useful avenue for the delivery of preventative programmes due to their scalability and accessibility. The efficacy of interventions that do not require additional support from a trained professional (self-guided) in this capacity is yet to be explored.

Method: A systematic search was conducted on the Cochrane Library, PubMed, PsycARTICLES, PsycINFO, OVID, MEDline, PsycEXTRA and SCOPUS databases. Studies were selected according to defined inclusion and exclusion criteria. The primary outcome was evaluating the effect of self-guided internet and mobile based interventions on incidence of anxiety and depression. The secondary outcome was effect on symptom severity.

Results: After identifying and removing duplicates, 3211 studies were screened, 32 of which were eligible for inclusion in the final analysis. Nine studies also reported incidence data (depression = 7, anxiety = 2). The overall Risk Ratios for incidence of anxiety and depression were 0.86 (95% CI [0.28, 2.66], $p = .79$) and 0.67 (95% CI [0.48, 0.93], $p = .02$) respectively. Analysis for 27 studies reporting severity of depressive symptoms revealed a significant posttreatment standardised mean difference of −0.27 (95% CI [−0.37, −0.17], $p < .001$) for self-guided intervention groups relative to controls. A similar result was observed for 29 studies reporting severity of anxiety symptoms with a standardised mean difference of −0.21 (95% CI [-0.31, −0.10], $p < .001$).

Conclusions: Self-guided internet and mobile based interventions appear to be effective at preventing incidence of depression, though further examination of the data suggests that generalisability of this finding may be limited. While self-guided interventions also appear effective in reducing symptoms of anxiety and depression, their ability to prevent incidence of anxiety is less clear. A heavy reliance on symptom measures in the data analysed suggests future research could benefit from prioritising the use of standardised diagnostic measuring tools to assess incidence. Future systematic reviews should aim to include more data from grey literature and reduce the impact of study heterogeneity.

1. Introduction

In 2017, it was estimated that 10.7% of the global population were living with a mental health disorder, the most common of which were depression (3.4%) and anxiety disorders (3.8%; Roser & Ritchie, 2018). This global prevalence is estimated to have gradually increased over the last several years (Richter et al., 2019). In the United Kingdom alone, problems related to mental health disorders are estimated to cost between £70 and £100 billion a year and the demand for mental health care is increasing (British Medical Association, 2018). Further, the global pandemic caused by the COVID-19 virus has continued to have a negative impact on the mental health and emotional wellbeing of the general public resulting in significant increases in symptoms indicative of depression and anxiety over the last two years (Bueno-Notivol et al., 2020; Jia et al., 2020; Pierce et al., 2020; Robinson, 2020; Shevlin et al., 2020). Now, more than ever, there is a need to ensure that every opportunity is taken to improve and adapt the ways people are supported to address their mental health problems and find ways to alleviate the economic burden of anxiety and depression (Moreno et al., 2020; Rosenberg et al., 2020).

* Corresponding author. University of Exeter, Washington Singer Building, Perry Road, Exeter, EX4 4QG, United Kingdom.
E-mail address: de292@exeter.ac.uk (D. Edge).

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Despite the proliferation of evidence-based treatments for anxiety and depression, there is little evidence that their prevalence is reducing. Three key arguments have been posited as to why this might be. First, traditional models of psychological intervention delivery cannot be made sufficiently widely available to meet the global need because there would never be sufficient therapists (Kazdin & Blase, 2011). Second, for disorders with relatively high levels of recurrence and relapse over time, such as anxiety and depression, even if acute treatment were made widely available, it is likely that only a partial reduction of the overall prevalence would be possible (Andrews et al., 2000; Jorm et al., 2017). Third, those in potential need of interventions do not always seek or take up treatment, often because of a combination of factors including limited effectiveness of available treatments (Furber et al., 2015), a lack of accessible services coupled with cost and time constraints (Giota & Kleftaras, 2014) and mental health related stigma (Clement et al., 2015). Effective prevention approaches are, therefore, key to reducing overall prevalence as they have the potential to reduce not only recurrent episodes of anxiety and depression, but also initial episodes, thus reducing the demand for acute treatment (Ormel et al., 2020). Consequently, there is now a growing need to develop effective interventions which focus on preventing anxiety and depression, as well as treating them (Cook et al., 2019; Jorm et al., 2017; Ormel et al., 2020; Topper et al., 2010). Typically, there are three different types of prevention approaches. Universal prevention focuses on the general population; selective prevention focuses on those at risk of developing anxiety or depression; indicated prevention targets people who show subthreshold symptoms but do not yet meet the full criteria for a diagnosis (Cuijpers, 2009; Ebert et al., 2018).

The use of internet and mobile-based versions of mental health interventions (IMIs) have been increasingly explored as a useful avenue for the delivery of preventative programmes (Giota & Kleftaras, 2014; Kazdin & Rabbitt, 2013; Musiat et al., 2014). This is because IMIs can be accessed instantly and offer a flexible way for interventions to be integrated into the daily life of the user while maintaining anonymity, thus reducing the effects of stigma (Ebert et al., 2018). IMIs also have the potential to reduce associated costs of therapy (such as fees for therapist resources or training; Paganini et al., 2018) and are considered to have potential for use in public-health due to their scalability and cost-effectiveness (Andersson & Titov, 2014; Emmelkamp et al., 2014). Typically, when delivering interventions, IMIs are either used independently by the client or as part of a "guided approach". Independent IMIs (often referred to as self-help, self-guided or unguided IMIs) have the user work through the intervention on their own without any additional support whereas guided IMIs offer some level of contact, support, and guidance with a trained professional (e.g., face-to-face, text chat, email) and require additional input. As well as stand-alone interventions, guided IMIs can also be used as an adjunct to an intervention which is, primarily, delivered in person (Ebert et al., 2018; Mehrotra et al., 2017). While there is some debate as to which approach can be considered more effective, self-guided IMIs offer some advantages due to an increased sense of empowerment for the user as well as increased flexibility and autonomy in comparison to the guided approach (Ebert et al., 2017). Further, as they do not require support from a trained clinician, self-guided IMIs have greater potential for scalability and accessibility making them more suitable for delivering preventative interventions at a population level as part of a public health approach. Self-guided IMIs are not limited by the capacity and volume of therapist or practitioner support and can be simultaneously used by multiple people – use by one person does not preclude use by another person, i.e., they are non-consumable, making them highly scalable.

While self-guided IMIs have been shown to be effective in the treatment of mental health problems in clinical populations, including disorders of anxiety and depression (Josephine et al., 2017; Olthuis et al., 2015; Taylor et al., 2021), their use as a preventative intervention is less clear. To date, we are only aware of two systematic reviews, and meta-analyses, exploring this topic area. Sander et al. (2016) collated the results of 17 randomised controlled trials (RCTs) involving IMIs which were aimed at the prevention of various mental health disorders including eating disorders, depression, post-traumatic stress disorder and generalised anxiety disorder. This included people with co-morbid physical health conditions (such as cancer). The review found that IMIs could be considered effective at reducing subthreshold symptomatology but that, due to a lack of data, a subsequent reduction of incidence could only be assumed (Sander et al., 2016). Another meta-analysis, completed by Deady et al. (2017), focussed on preventative IMIs targeting only anxiety and depression and examined data from 10 RCTs. Again, due to a lack of studies providing incidence data, it was not possible to determine whether the onset of anxiety and depression had been effectively prevented. Similar to Sander et al. (2016) however, small but significant positive effects on symptom severity were observed (Deady et al., 2017). In both reviews there was a lack of RCTs specifically targeting a non-clinical sample. Some studies did not ensure participants were not meeting diagnostic criteria before the intervention as needed to distinguish acute treatment from prevention (Sander et al., 2016) and the primary outcome reported was often short-term symptom reduction rather than a decrease in disorder incidence (Deady et al., 2017; Sander et al., 2016). While both reviews found evidence showing that IMIs can reduce symptoms of anxiety and depression, reduction of symptomatology alone is not necessarily indicative of prevention. Further, it is not clear whether the observed benefits can be achieved using solely self-guided IMIs as both reviews also examined IMIs that had additional support from trained professionals or were used as part of a guided/supported approach. The ability for self-guided IMIs to reduce incidence and act as a prevention mechanism for anxiety and depression is, therefore, still not clear, and their effect on symptom severity has not been thoroughly investigated. As these reviews are now five years out of date in a rapidly growing field, a more up to date review of the evidence is required.

The need for cost effective, widely available, preventative interventions is apparent. IMIs that do not need to be administered by, or involve, trained professionals, offer an opportunity for low cost, highly scalable, preventative interventions to be accessed as part of a public health approach towards alleviating the economic burden of anxiety and depression. This potential, however, is yet to be robustly evaluated. The aim of this systematic review and meta-analysis, therefore, is to examine the effect of self-guided IMIs on incidence of anxiety and depression as well as symptom severity.

2. Methods

2.1. Registration and study protocol

This systematic review was registered on PROSPERO (registration number CRD42021264932) and conducted according to PRISMA guidelines (Page et al., 2021).

2.2. Eligibility

Eligibility for inclusion in the final analysis are presented using the population, intervention, comparator, outcome, study-design (PICOS) model. An overview of the inclusion criteria for this review criteria is given in Table 1.

2.2.1. Population

Studies were included in the review only if the entire sample was from an adult population (16 years or above). To ensure all forms of preventative intervention were included, studies with participants who exhibited elevated symptoms of anxiety or depression at baseline were eligible for inclusion, providing it was indicated that they did not have an established diagnosis. Any studies which explicitly identified any participants as having a current diagnosis of anxiety or depression at baseline were excluded. Studies involving participants with a history, or

Table 1
PICOS Criteria to evaluate eligibility for inclusion in meta-analysis.

	Inclusion Criteria	Exclusion Criteria
Population	Must be: - Human - Aged 16 years or above - No report of participants having a diagnosis of anxiety and/or depression at baseline. Studies with participants who were assumed to be healthy but reported elevated levels of distress at baseline, including indications of caseness on symptom measures (i.e., indicated prevention) were included, providing the presence of a diagnosis was not explicitly evident	- Any participants under the age of 16 (Children) in the sample - Reported to include participants with a diagnosis of anxiety and depression at baseline (indicating treatment rather than prevention)
Intervention	Must be both: - A self-guided intervention delivered either via the internet or a mobile phone application. IMI's which involve the use of "automatic reminders" to help retain engagement were also included. - Derived from evidence-based psychological interventions such as Cognitive Behavioural Therapy (CBT), mindfulness, or other associated derivatives	Interventions which involve either - face to face contact with a clinician - contact with a clinician, such as emails, texts, asynchronous or synchronous online written communication, telephone or video-calls - contact with a clinician which is augmented by automated/self- guided components.
Comparator	Main interventions are compared with one or both: - An internet- or mobile-based placebo treatment group - regular treatment controls (such as waitlist, treatment as normal or face to face-based intervention)	Main intervention has no control or comparison group
Outcome	At least one or more of the following outcomes need to be present in the study: - Primary outcome establishing whether onset of anxiety and/or depression occurred between baseline and follow-up using a binary outcome (present/not present), determined by one of the following: o Use of standardised diagnostic interview (i.e., Mental Health Composite International Diagnostic Interview, Structured Clinical Interview for DSM-IV Axis I Disorders, Mini-International Neuropsychiatric Interview) o Measures of symptoms indicative of anxiety or depression (e.g., GAD-7 or PHQ-9), with established cut-offs to indicate caseness and where the study references the intent behind its use was to determine onset and the outcome is given as a binary condition - Primary or secondary measures for one or more of the following: o Symptoms indicative of anxiety and/or depression (e.g. PHQ-9, GAD-7)	Primary measures for one or more of the following - behavioural outcomes (e.g., incidents of self-harm or aggression) - physiological outcomes (e.g., heart-rate or skin temperature)
Study Design	Randomised controlled trial or randomised clinical trial with outcome measurements taken at baseline and at least one other time point after being randomised, written in English	Single case studies, non-randomised trials or prospective cohort studies with no evidence of a randomisation process or written in a foreign language

previous diagnosis, of anxiety or depression were eligible so that both primary and secondary prevention could be considered. Studies where the primary focus was evaluating treatment for a medical condition, or on preventing anxiety/depression in the context of a co-morbid physical health condition (such as epilepsy or a terminal illness) were excluded. This is because such interventions are likely to target problems associated with the identified medical conditions (such as chronic pain or making life adjustments; Thabrew et al., 2018), thus limiting their generalisability to a wider population.

2.2.2. Intervention

For a study to be included, the intervention being evaluated had to be self-guided (i.e., a standalone intervention without additional support or contact with a trained clinician) and delivered via the internet or a mobile phone application, while the content had to be derived from evidence-based psychological interventions. This definition was based on approaches identified by Kampling et al. (2014) and included interventions such as behaviour therapy, cognitive behavioural therapy, psychodynamic psychotherapy, behaviour modification and third wave cognitive behavioural therapies (e.g., mindfulness-based cognitive therapy, acceptance and commitment therapy or compassion focused therapy).

2.2.3. Comparator

Studies were only included if they had a control group. Acceptable control groups included: IMI-based placebo treatment groups; regular treatment controls (such as waitlist, treatment as usual or face to face/guided intervention) or guided treatment controls (i.e., an IMI used as part of a supported approach involving additional contact with a clinician or other mental health professional).

2.2.4. Outcomes

Studies were included if the reported outcomes were either the incidence of anxiety/depression during the follow-up period or a change in symptom severity from before to after the intervention relative to a control. For this review, two approaches were used to establish incidence. A more conservative, and reliable, approach was the use of a standardised diagnostic interview to determine onset, such as the Structured Clinical Interview for the Diagnostic and Statistical Manual-IV Axis I Disorders (First & Gibbon, 2004) or the Mini-International Neuropsychiatric Interview (Sheehan et al., 1998). The other approach, where standardised interviews were not utilised, was the use of validated cut-offs to indicate the onset of depression or anxiety caseness (such as a score of 10 or more on the Patient Health Questionnaire- PHQ-9; Kroenke et al., 2010, 2016) providing it was clear that intent was to determine onset and the outcome was given as a binary condition. When assessing symptom severity, studies were only included if they used a valid, reliable measure to assess the severity of symptoms indicative of anxiety/depression both at baseline and at least one follow-up assessment after the randomisation of participants.

2.2.5. Study design

To be included in the review, studies had to be identified as randomised controlled trials or clinical trials, with outcome measurements taken at baseline and at least one other time point after participants were randomised. Only studies written in English and available in full

text were included.

2.3. Search strategy

The search was conducted on 2nd August 2021 using the Cochrane Library, **PubMed**, **PsycARTICLES**, **PsycINFO**, **OVID, MEDline**, **PsycEXTRA** and **SCOPUS** databases to identify relevant articles published from January 2000 to July 2021. The search strategy used key terms to describe IMIs and preventative interventions for anxiety and depression combined from the search strategies provided in two previous systematic reviews (Deady et al., 2017; Sander et al., 2016). Additional key terms were identified from a previous narrative review of preventative IMIs (Ebert et al., 2017). An overview of the search strategy is given in Table 2.

2.4. Study selection process

All aspects of the selection process were conducted using Raayan, a web-based application for completing systematic reviews (Ouzzani et al., 2016). Article screening was conducted by the lead researcher (DE) examining the title and abstract using the following selection criteria: (i) reference to an evaluation of a psychological intervention and (ii) reference to prevention of anxiety/depression OR reference to improvement of protective factors (such as emotional/mental well-being) OR reference to the reduction of risk factors (such as rumination or worry). All articles which met both these criteria then had their full text evaluated using the PICOS criteria provided above. A second reviewer (JM) independently completed full text evaluations for 25% of the studies deemed eligible after screening. Agreement between the two reviewers was very good at 92.9% ($\kappa = 0.67$, SE = 0.14, 95% CI [0.40, 0.94]). Remaining disagreement was resolved by discussion. An illustration of the study selection process is given in Fig. 1.

2.5. Data collection process

For each study deemed eligible by the full text review, the following data were extracted by the lead researcher: (1) information about the study (authors, year of publication, country where conducted), (2) characteristics of the study (sample size of participants randomised, number of groups, control group characteristics, participant characteristics, rate of attrition, number of follow-ups after primary end point), (3) information regarding the intervention (name, delivered via internet or mobile, duration), (4) the disorder being measured (anxiety, depression or both) (5) outcomes relevant to the review (onset and/or severity including pre/post means and standard deviations). Any studies reporting the standard error (SE) were converted into standard deviations (SD) using a mathematical formula on Microsoft Excel ($SD = SE\sqrt{N}$). For studies where outcome data was missing or deficient, authors were contacted and asked to provide further information. All authors who were contacted responded with the information requested.

Table 2
Overview of search strategy.

Construct	Search terms
Prevention	prevent*, reduc*, minimi* decrease, resilience, at? risk, early intervention, subclinical, subthreshold, emotional?health
Internet or mobile-based interventions (IMIs)	app, application, mobile, mobile phone, internet, e? mental health, m?mental health, smartphone, smart?phone, cell?phone, remote, online, Behavio? ral intervention technolog* BIT, m?health, IMI, digital, digital health intervention*, DHI, e?therapy, mobile?based intervention, ICare, e?health, digital treatment, internet intervention, web?based, self? help, self?guided, unsupported, app?based, technology?assisted, self?directed, telehealth, telemedicine, remote intervention
Anxiety/Depression	mental illness*, mental disorder, mental health*, anxiety, depression, disorder, well?being, worry, rumination, negative thinking, mood disorder, generali?ed anxiety disorder, GAD, panic, low mood
RCT	randomi?ed control* trial, randomi?ed clinical trial, RCT, random allocation,

Note.
*denotes a truncation retrieving any combination of letters following the string.
? denotes a wildcard for retrieving alternate spellings.

Table 3
Further details of excluded articles.

PICOS Criteria	Reason for Exclusion	N
Population	Participants with diagnosis at baseline	35
	Included participants under 16 years of age	34
	Depression/anxiety in the context of a co-morbid physical health condition	6
Intervention	Involved contact with clinician/not self-guided	55
	Not delivered via internet/mobile phone	23
	Not derived from evidence-based psychological interventions[a]	7
Comparator	No comparison group	7
	Comparison group was not a placebo intervention	1
Outcomes	Outcomes not measuring anxiety or depression	15
	Primary outcome was physiological	3
	Primary outcome was behavioural	2
Study Design	Not randomised	4
	Study Protocol/Review/Not a clinical trial	56

[a] Note: evidence-based psychological intervention included models adopted in therapeutic treatment such as CBT, mindfulness, or other associated derivatives as identified by Kampling et al. (2014).

2.6. Risk of bias assessment

The quality of the evidence obtained was established by assessing the risk of bias for each study according to the Cochrane Collaboration's tool for assessing risk of bias in randomised trials (Higgins et al., 2011). The lead researcher completed each assessment using the revised tool to assess risk of bias in randomised trials (RoB2; Sterne et al., 2019). Reliability was established by a second reviewer (JM) blindly completing assessments for a random selection of 25% of the studies. Both reviewers gave ratings (either "low risk of bias", "some concerns" or "high risk of bias") for each assessment domain using the tool's built-in assessment algorithm. A weighted Cohen's Kappa suggested an acceptable level of agreement for the overall risk of bias rating given for each study by the two reviewers ($\kappa = 0.69$, SE = 0.19, 95% CI [0.32, 1]).

2.7. Data analysis

All data was analysed using Review Manager version 5.4 (The Cochrane Collaboration, 2020). For the primary outcome to determine effect on incidence, risk ratios were calculated using the relative rate of participants meeting diagnostic criteria across the follow-up period in the intervention arm relative to the control arm at the first follow-up point. Additional sensitivity analyses were also conducted to further examine the consistency of the results.

For the secondary outcome to determine effect on symptom severity, standardised Mean Differences (SMDs) with 95% confidence intervals were calculated for each continuous measure to give an indication of the main effect of group using post intervention mean and standard deviation scores. For studies with three or more groups (n = 8), two compared guided and self-guided versions of an app, three compared multiple versions of a self-guided app with a control group and three compared an app with a placebo/attention control as well as a waitlist control group. For the three studies evaluating multiple versions of a self-guided app the mean ($\overline{X}_x$), standard deviation (S_x) and number of participants (n_x) for each group were used to give a combined mean (X_c) and combined

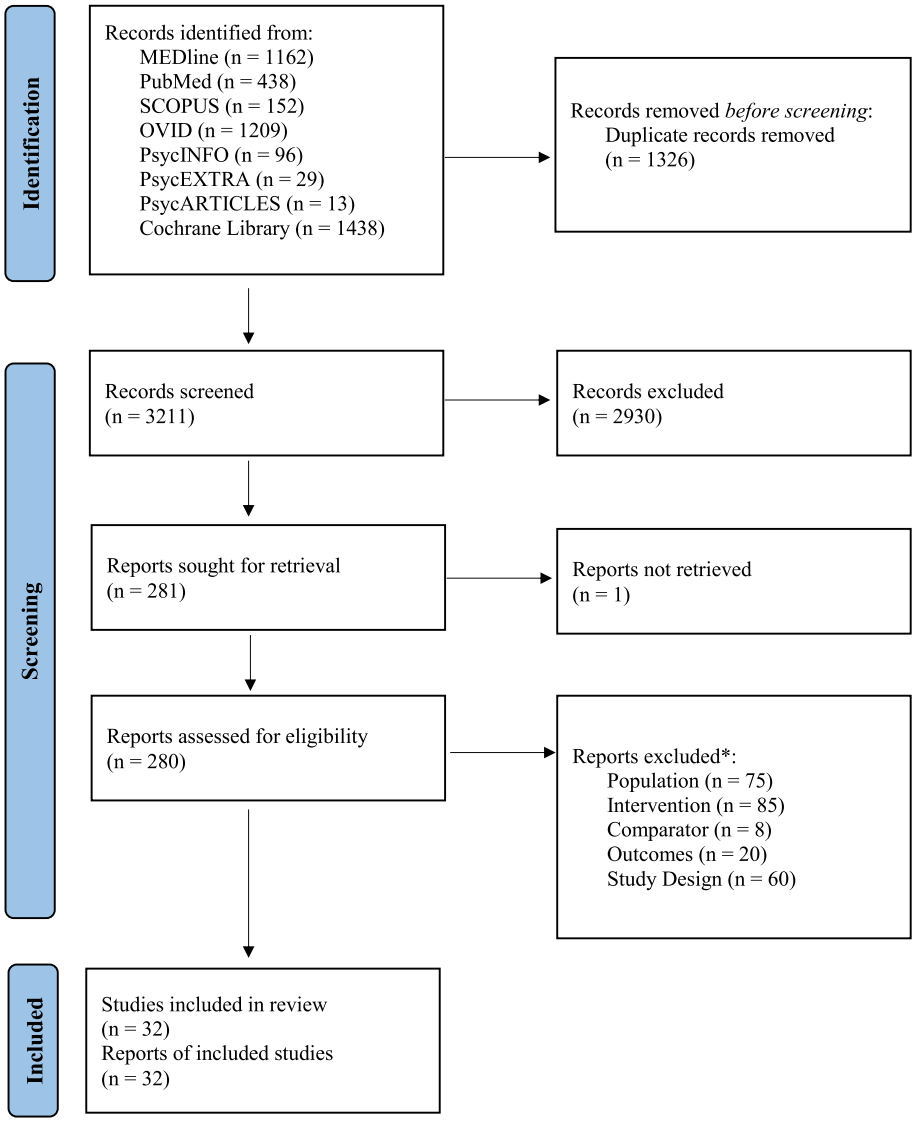

Fig. 1. PRISMA flow diagram of systematic review process
*Further exclusion details provided in Table 3.

standard deviation (S_c) for use in the meta-analysis using the following equations:

$$X_c = \frac{n_1\overline{X}_1 + n_2\overline{X}_2}{n_1 + n_2}$$

$$S_c = \frac{n_1\left[{S_1}^2 + (\overline{X}_1 - \overline{X}_c)\right] + n_2\left[{S_2}^2 + (\overline{X}_2 - \overline{X}_c)\right]}{n_1 + n_2}$$

For the two studies comparing guided and self-guided versions of the same app, only data from the self-guided group were used so that the studies met inclusion criteria for the review. For the three studies which had multiple control groups, only data from the waitlist control group was used in the meta-analysis as this was the most common comparator for all the studies included in the review (53%). Further details for each study and the data used in the analysis are given in Table 4. As a variety of scales were used to measure symptom severity for anxiety and depression, a random effects meta-analysis was used to determine overall estimates (Borenstein et al., 2009).

Study heterogeneity was examined using the I^2 statistic where 0% denotes no observed heterogeneity, 25% is "low", 50% is "moderate" and 75% is "high" (Higgins & Thompson, 2002). The weighting of each study was determined automatically via Review Manager during analysis based on the inverse variances of their effect estimates. The effect of publication bias was estimated informally via examination of a funnel plot (see results section).

3. Results

3.1. Overview

The systematic search yielded 4537 articles. After duplicates had been identified and removed, 3211 had their titles and abstracts screened. Following a full-text review of 280 articles (70 of which were also examined by a second reviewer), 32 met the eligibility criteria and were included in the final meta-analysis (see Table 4).

3.2. Quality assessment

Of the 32 studies included, five were rated as having an overall high risk of bias, 19 were identified as having some concerns and eight were rated as having a low risk of bias. The process of randomisation was mostly acceptable with 10 studies rated as having some concerns due to baseline differences between groups indicating an issue with the randomisation process (Beshai et al., 2020; Deady et al., 2020; Howell et al.,

Table 4
Summary of studies included in the final meta-analysis.

Study	Sample Size	Country	Participants	Age, Mean (SD)	Type	Intervention Description (Duration)	Conditions	Primary end point (Retention)	Follow-ups	Measures[a]	Capturing	Prevention Type
Batterham et al. (2018) [d]	194	Australia	Adults, 18 + in Australia with elevated, but not clinically severe, scores on the anxiety and depression symptom scales (Female, 84.4%)	36.18 (19)	Internet	FitMindKit, online intervention developed using a narrative approach. The study examined two versions of the programme, one was tailored to individual needs and the other was not (2 weeks)	1. FitMindKit (Tailored) 2. FitMindKit (standard) 3. Healthwatch (placebo)	2 weeks (38.7%)	3 months	1. NA 2. PHQ-9, GAD-7	Anxiety & Depression	Selective
Batterham et al. (2017)	845	Australia	Adults, 18–64, living in Australia who met criteria for Insomnia and PHQ-9 score >4 and < 20. Any meeting the criteria for current Major Depression, bi-polar or active suicidality using the Mini International Neuropsychiatric Interview were excluded (Female, 74.5%)	42.5 (12.2)	Internet	SHUTi, an online insomnia programme based on CBT delivers six modules: two behaviourally focused modules that included sleep restriction and stimulus control, cognitive restructuring, sleep hygiene and relapse prevention (9 weeks)	1. SHUTi 2. Healthwatch - online placebo intervention providing general health education	9 weeks (50.6%)	1. 6 months 2. 12 months 3. 18 months	1. PHQ-9 ≥ 10 2. PHQ-9, GAD-7	Depression & Anxiety	Indicated
Batterham et al. (2021)	1986	Australia	Adults 18+ reporting moderate psychological distress measured by a score of 8–17 on the Distress Questionnaire - 5 (84.9% female)	41.4 (9)[b]	Internet	FitMindKit, CBT-based, 12 modules consisting of psychoeducation, cognitive reframing, problem solving and mindfulness (4 weeks)	1. FitMindKit 2. Web-based health programme (attention control)	4 weeks (34%)	Nil	1. NA 2. PHQ-9, GAD-7	Anxiety & Depression	Selective
Beshai et al. (2020)	456	Worldwide	English speaking adults aged 18+ with scores of ≥ 8 on PHQ-9 or GAD-7 (Female, 43.9%)	35.13 (10.57)	Internet	Mind-Op, combines mindfulness, self-compassion, and goal-setting exercises into a brief self-guided intervention (4 weeks)	1. Mind-Op 2. weekly videos of images (placebo)	6 weeks (34.9%)	Nil	1. NA 2. PHQ-9, GAD-7	Anxiety & Depression	Indicated
Bruehlman-Seneca et al. (2020)	221	USA	Adults 18–25 first year university students (59.3% female)	18.68 (.35)	Mobile app	Nod - co-developed by Grit Digital Health and Hopelab. Nod incorporates positive psychology, mindfulness-based self-compassion, and cognitive behavioural skill-building exercises to address loneliness among first-year college students (4 weeks)	1. Nod 2. No intervention	4 weeks (96.8%)	8 weeks	1. NA 2. PHQ-9, GAD-7	Anxiety & Depression	Universal
Cavanagh et al. (2013)	104	UK	Adults, 19–51 years, students from a University in the South of England (female, 88.4%)	24.66 (6.44)	Internet	Learning Mindfulness, online Intervention (2 weeks)	1. Learning Mindfulness 2. No intervention	2 weeks (55.8%)	Nil	1. NA 2. PHQ-4	Anxiety & Depression	Universal
Cheng et al. (2019)	1358	USA	Adults, 18+ with a diagnosis of Insomnia	45.05 (15.5)	Internet	Sleepio, programme initially designed to help	1. Sleepio	12 weeks (47.5%)	12 months	1. QIDS classification	Depression	Selective

(*continued on next page*)

Table 4 (*continued*)

Study	Sample Size	Country	Participants	Age, Mean (SD)	Type	Intervention Description (Duration)	Conditions	Primary end point (Retention)	Follow-ups	Measures[a]	Capturing	Prevention Type
			but no diagnosis of a mood disorder (Female, 78.9%)			treat insomnia, uses digital CBT based principles (d-CBTi) (12 weeks)	2. Psycho-education about sleep hygiene			of severe depression 2. QIDS-SR		
Christensen et al. (2014) [e]	558	Australia	Australians aged 18–30 years registered on the Australian Electoral Roll who scored >5 on GAD-7 but did not meet current diagnosis using the MINI (Female, 80.6%)	25.64 (3.23)	Internet	E-couch (Anxiety and Worry modules) consisted of an integrated program of psychoeducation, CBT, relaxation and physical activity promotion (10 weeks)	1. E-couch (no reminders) 2. E-couch (telephone reminders) 3. E-couch (email reminders) 4. Healthwatch (no reminders) 5. Healthwatch (email reminders)	10 weeks (64.2%)	1. 6 months 2. 12 months	1. MINI Assessment (GAD) 2. GAD-7, CES-D	Anxiety & Depression	Indicated
Christensen et al. (2016)	1149	Australia	Adults, 18–64, living in Australia who met criteria for Insomnia and PHQ-9 score >4 and < 20. Any meeting the criteria for current Major Depression, bi-polar or active suicidality using the MINI were excluded (Female, 74.5%)	42.73 (12.21)	Internet	SHUTi, an online insomnia programme based on CBT delivers six modules: two behaviourally focused modules that included sleep restriction and stimulus control, cognitive restructuring, sleep hygiene and relapse prevention (6 weeks)	1. SHUTi 2. Healthwatch - online placebo intervention providing general health education	6 weeks (50.6%)	6 months	1. PSF 2. PHQ-9, GAD-7	Anxiety & Depression	Indicated
Cook et al. (2019) [f]	235	UK	University students aged 18–24 based in the United Kingdom with elevated levels of Repetitive Negative Thinking and a score <15 on the PHQ-9 (Female, 83%)	20.41 (1.51)	Internet	MindReSolve, rumination focused cognitive behavioural therapy treatment. The study examined 2 variants of the programme, one was guided with clinical support and the other was unguided (12 weeks)	1. MindReSolve (unguided) 2. MindResolve (guided) 3. No intervention	15 months (68.5%)	1. 3 months 2. 6 months 3. 15 months	1. SCID-I 2. PHQ-9, GAD-7	Anxiety & Depression	Indicated
Deady et al. (2020)	2271	Australia	Adults, 18+ Working Australians from Male Dominated Industries with a PHQ-9 score <14 (Female 28.5%)	40.26 (10.63)	Mobile app	HeadGear, an intervention centred on behavioural activation (BA) and mindfulness (30 days)	1. HeadGear 2. Attention based control app which had no intervention	3 months (46.93%)	12 months	1. PHQ-9 diagnostic Algorithm 2. PHQ-9, GAD-2	Anxiety & Depression	Selective
Ebert et al. (2016)	263	Germany	Adults, 18+ from a working population of a German health insurance company with heightened levels of perceieved stress scoring ≥ 22 on the Perceieved Stress Scale (Female, 71.5%).	42 (9)	Internet	GET.ON, based on the Lazarus and Folkman transactional model of stress and its distinction of problem-focused and emotion-focused coping. The intervention was developed using evidence-based material on problem-solving and emotion regulation (7 weeks)	1. GET.ON 2. No intervention	7 weeks (94.3%)	6 months	1. NA 2. CES-D, HAD-A	Anxiety & Depression	Selective

(*continued on next page*)

Table 4 (*continued*)

Study	Sample Size	Country	Participants	Age, Mean (SD)	Type	Intervention Description (Duration)	Conditions	Primary end point (Retention)	Follow-ups	Measures[a]	Capturing	Prevention Type
Enrique Roig et al. (2020) [g]	83	UK	Adult, 18+ students enrolled at Trinity College Dublin (female, 83%)	26 (11)[c]	Internet	Space for Resilience, a 7-module program aimed at promoting resilience. Developed with the principles of positive psychology and incorporates cognitive behavioural elements. The study tested two versions of the app, one entirely automated and one with human support (8 weeks)	1. Space for Resilience (human support) 2. Space for Resilience (self-guided) 3. No intervention	8 weeks (71.1%)	Nil	1. NA 2. PHQ-4	Anxiety & Depression	Universal
Farrer et al. (2019)	200	Australia	Adults, 18+ undergraduate and postgraduate students from mid-sized university in a major capital city in Australia who identified as feeling "stressed, down or overwhelmed" scoring >15 on the Kessler Psychological Distress Scale (Female, 77.5%)	22.1 (4.86)	Internet	The Uni Virtual Clinic (UVC), a comprehensive online mental health program delivers information via tailored factsheets, brief screening tools that provide [automated] feedback about symptom severity and normative data, and psychotherapeutic modules (e.g., cognitive behaviour therapy, mindfulness) (6 weeks)	1. UVC 2. No intervention	6 weeks (72%)	3 months	1. NA 2. PHQ-9, GAD-7	Anxiety & Depression	Indicated
Fiol-DeRoque et al. (2021)	482	Spain	female health care workers aged >18 years who had provided health care to patients with COVID-19 during the viral outbreak in Spain (Female, 83.2%)	41.37 (10.4)	Mobile app	PsyCovidApp, intervention targeting emotional skills, healthy lifestyle behaviour, burnout, and social support based on CBT and mindfulness approaches (2 weeks)	1. PsyCovidApp 2. non-psychologically based app (placebo)	2 weeks (90.5%)	Nil	1. NA 2. DASS-21	Anxiety & Depression	Selective
Fuller-Tyszkiewicz et al. (2020)	183	Australia	Adults, 18+ who were supporting a friend/ relative with a physical/ mental disability (Female, 94.5%)	39.5 (6.27)	Mobile app	StressLess, a 5-week, self-directed intervention, based on the principles of second- and third-wave CBTs (5 weeks)	1. StressLess 2. StressMonitor (monitoring without intervention)	5 weeks (72.7%)	4 months	1. NA 2. DASS-21	Anxiety & Depression	Selective
Goldberg et al. (2020) [h]	343	USA	Adults 18+ without prior meditation experience (84.5% female)	41.74 (12.52)	Mobile app	Healthy Minds Programme (HMP), a self-guided mindfulness/ meditation based intervention with didactic podcast based learning material and guided meditation practice. There were two versions tested, one which focussed on cultivating mindful attention (awareness) and the other	1. HMP (awareness) 2. HMP (connection) 3. No intervention	8 weeks (46.1%)	Nil	1. NA 2. PROMIS	Anxiety & Depression	Universal

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Table 4 (*continued*)

Study	Sample Size	Country	Participants	Age, Mean (SD)	Type	Intervention Description (Duration)	Conditions	Primary end point (Retention)	Follow-ups	Measures[a]	Capturing	Prevention Type
						positive relationships with self and others (connection) (8 weeks)						
Gosling et al. (2018)	1149	Australia	Adults, 18–64, living in Australia who met criteria for Insomnia and had a PHQ-9 score >4 and < 20. Any meeting the criteria for current Major Depression, bi-polar or active suicidality using the MINI were excluded (Female, 74.5%)	42.7 (12.2)	Internet	SHUTi, an online insomnia programme based on CBT delivers six modules: two behaviourally focused modules that included sleep restriction and stimulus control, cognitive restructuring, sleep hygiene and relapse prevention (9 weeks)	1. SHUTi 2. Healthwatch - online placebo intervention providing general health education	9 weeks (50.6%)	6 months	1. NA 2. GAD-7	Anxiety	Indicated
Howell et al. (2019)	943	USA	Adults, 18+ graduate students from a US medical university (Female, 68%)	27.45 (7.08)	Internet	MoodGYM, web-based CBT (4 weeks)	1. MoodGYM 2. self-assessment of mental health and then given feedback	3 months (63%)	Nil	1. GAD-7 $\geq$ 10 2. GAD-7	Anxiety	Universal
Imamura et al. (2014)	762	Japan	Adults, 18+ recruited from 2 Japanese companies who were not diagnosed with a major depressive disorder, lifetime bipolardisorder and had not recently taken a specified amount of sick leave for mental or physical health problems. (Female, 16.1%)	37.6 (9.01)	Internet	Manga themed iCBT programme (6 weeks)	1. iCBT 2. Stress management email messages (placebo)	3 months (79.5%)	6 months	1. BDI-II 2. BDI-OO	Depression	Universal
Keller et al. (2021)	117	Germany	Adults, 19–71 in a heterosexual relationship and feeling distressed due to issues with their relationship determined by a score of 18 or lower on a partnership satisfaction questionnaire (Female, 66.6%)	40.4 (10.6)	Internet	PaarBalance, programme based on Integrative Behaviour Therapy for couples (12 weeks)	1. PaarBalance 2. No intervention	12 weeks (73.5%)	24 weeks	1. NA 2. PHQ-9, GAD-7	Anxiety & Depression	Selective
Lintvedt et al. (2013)	163	Norway	Adults, 18+ students at the university of Trosmo and University College of Trosmo with elevated distress identified as a score of $\geq$ 20 on the Kessler Psychological Distress Scale (Female, 76.7%)	28.15 (7.38)	Internet	MoodGYM, self-help programme based on principles of CBT, interpersonal therapy and relaxation techniques. BluePages, evidenced based information about depression. The intervention comprised a combination of both programmes (8 weeks)	1. MoodGYM & BluePages combined 2. No intervention	8 weeks (62.0%)	Nil	1. NA 2. CES-D	Depression	Selective

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Table 4 (*continued*)

Study	Sample Size	Country	Participants	Age, Mean (SD)	Type	Intervention Description (Duration)	Conditions	Primary end point (Retention)	Follow-ups	Measures[a]	Capturing	Prevention Type
Litvin et al. (2020) [i]	709	UK	Adults 18+ in the UK general population, employed by Bosch. Recruited via a company wellbeing programme (38.9% female)	38.6 (9) [b]	Mobile app	eQuoo, a gamified app with 5 levels which teaches users psychological skills extracted from CBT, positive psychology and systemic therapies (5 weeks)	1. eQuoo 2. Non gamified CBT app 3. No intervention	5 weeks (49.9%)	Nil	1. NA 2. Single item Anxiety Score	Anxiety	Universal
Lokman et al. (2017)	329	Holland	Adults, 18+ from the general population with mild to moderate depressive symptoms defined as 14–38 on the IDS-SR (Female 75.7%)	43.25 (12.95)	Internet	Web-based complaint-directed mini-interventions (CDMIs), designed to prevent or reduce depressive complaints largely based on cognitive behavioural techniques (4 weeks)	1. CDMIs 2. No intervention	3 months (72%)	6 months	1. NA 2. IDS-SR, GAD-7	Anxiety & Depression	Indicated
Nguyen-Feng et al. (2019)	382	USA	Adults, 18+ undergraduate students from a midwestern university who were "feeling stressed" (female, 77%)	21.3 (4.2)	Mobile app	Mindfulness based app which aims to teach users about their perceived present control over stressful events (2 weeks)	1. Mindfulness based app 2. Mental health assessment with no intervention	14 days (83.8%)	5 weeks	1. NA 2. DASS-21	Anxiety & Depression	Selective
Orosa-Duarte et al. (2021) [j]	154	Spain	Students of medicine, psychology, nursing or nutrition aged 18+ who could speak Spanish (85% female)	23 (4.16)	Mobile app	REM Volver a Case (Mindfulness based Emotion, going home), an 8-stage guided mindfulness training programme (8 weeks)	1. REM Volver 2. In person 3. No intervention	8 weeks (54.5%)	Nil	1. NA 2. STAI-T	Anxiety	Universal
Perry et al. (2017)	540	Australia	Adolescents in their final year of secondary school (Ages 16–18) from 10 schools in the Sydney metropolitan area (Female, 63.1%)	NA	Internet	SPARX-R, a revised version which was developed as an unguided, interactive program using the format of a fantasy game providing cognitive behavioural skills (7 weeks)	1. SPARX-R 2. lifeSTYLE (placebo intervention)	7 weeks (75.2%)	1. 6 months 2. 18 months	1. MDI 2. MDI, SCAS – GAD	Anxiety & Depression	Universal
Powell et al. (2020)	2116	England	Adults, 18+ in the general population who self-reported some level of social anxiety symptoms but who were not receiving treatment for social anxiety (Female, 80.2%)	37.17 (13.75)	Internet	E-couch (social anxiety module), a self-directed interactive program based on cognitive behavioural therapy principles (6 weeks)	1. E-couch 2. No intervention	6 weeks (56.8%)	1. 3 months 2. 6 months 3. 12 months	1. NA 2. SPIN-17	Anxiety	Indicated
Przybylko et al. (2021)	425	Australia	Adults 18+ recruited by a faith-based organisation (71.7% female)	47.43 (14.4)	Internet	The Live More Project, 10-week, modular intervention underpinned by the theory of planned behaviour by focusing on shifts in attitude, education and promoting	1. Live More 2. No intervention	12 weeks (70.7%)	12 weeks	1. NA 2. Dass-21	Anxiety & Depression	Universal

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Table 4 (*continued*)

Study	Sample Size	Country	Participants	Age, Mean (SD)	Type	Intervention Description (Duration)	Conditions	Primary end point (Retention)	Follow-ups	Measures[a]	Capturing	Prevention Type
						social engagement (10 weeks)						
Quinones et al. (2019) [k]	994	Not stated	Adults, 18+ from general population with elevated levels of compulsive internet use, lived with partners and lacked mindfulness experience (Female, 39%)	40.01 (.83)	Mobile app	Headspace mindfulness app, the users were given daily access for 10-min meditation podcasts via the app or directly from the website. The application sent daily reminders to all participants (2 weeks)	1. Headspace 2. Muscle relaxation podcast 3. No intervention	2 weeks (36.5%)	Nil	1. NA 2. PHQ-4	Anxiety & Depression	Selective
Twomey et al. (2014)	201	Ireland	Adults, 18–61 on the waiting list for 6 mental health providers in Northern Ireland presenting with symptoms of anxiety, depression or stress (Female, 73.8%)	35.3 (10.3)	Internet	MoodGYM, web-based CBT (32 days)	1. MoodGYM 2. No intervention	32 days (32.8%)	12 weeks	1. NA 2. DASS-21	Anxiety & Depression	Indicated
Vukčević et al. (2020)	120	Serbia	Adults, 18+ general population living in Serbia (Female, 75%)	32.23 (10)	Internet	Online Expressive Writing intervention with sessions lasting 20 min every 3 days (2 weeks)	1. Expressive Writing 2. No intervention	2 weeks (86.7%)	1 month & 2 weeks	1. NA 2. DASS-21	Anxiety & Depression	Universal

State and Trait Anxiety Inventory (STAI-T), Patient Health Questionnaire 9 (PHQ-9), Generalised Anxiety Disorder Assessment 7 (GAD-7), Depression Anxiety and Stress Scale (DASS-21), Patient-Reported Outcomes Measurement Information System (PROMIS), Patient Health Questionnaire 4 (PHQ-4), Generalised Anxiety Disorder Assessment 2 (GAD-2), Social Phobia Inventory (SPIN-17), Quick Inventory of Depressive Symptomatology (QIDS), Quick Inventory of Depressive Symptomatology – Self report (QIDS-SR), Inventory of Depressive Symptomatology-self report (IDS-SR), The Mini International Neuropsychiatric Interview (MINI), Major Depression Inventory (MDI), Spence Children's Anxiety Scale – Generalised Anxiety Disorder subscale (SCAS-GAD), Center for Epidemiological Studies-Depression (CES-D), Hospital Anxiety and Depression Scale – anxiety subscale (HAD-A), Psychiatric Symptom Frequency Scale (PSF), Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I).

Note.

[a] 1 = primary outcome (incidence), 2 = secondary outcome (severity).

[b] Estimation based on age ranges reported as a categorical variable.

[c] Numbers reported are the median and inter-quartile range.

[d] Means and SDs from both the FitMidKit (Tailored) and FitMindMit (Standard) groups were combined and compared with the waitlist control.

[e] The study provided incidence data for the combined treatment and control groups. Severity data was calculated by combining the three intervention groups and the two control groups.

[f] Data comparing the unguided group with the control was used so the study met inclusion criteria for this review.

[g] Data comparing the self-guided group with the control was used so the study met inclusion criteria for this review.

[h] Means and SDs from both the HMP(awareness) and HMP(connection) groups were combined and compared with the waitlist control.

[i] Data comparing eQuoo with the waitlist control was used.

[j] Data comparing the app with the waitlist control was used.

[k] Data comparing Headspace with the waitlist control group was used.

2019; Lintvedt et al., 2013; Lokman et al., 2017; Perry et al., 2017; Twomey et al., 2014) or a lack of information regarding concealment of the allocation sequence (Goldberg et al., 2020; Litvin et al., 2020). One study gave very little information regarding the randomisation process, other than stating that participants were randomly allocated to their groups (Quinones & Griffiths, 2019).

Deviations from intended interventions suggested a high risk of bias in three studies. One study excluded participants after they had been randomised due to them reporting moderate levels of anxiety at baseline (Howell et al., 2019), which effectively removes the benefits of randomisation. Two studies did not appear to use Intention to Treat analysis (ITT) and did not provide enough information to determine how or why participants may have been excluded (Nguyen-Feng et al., 2019; Twomey et al., 2014).

Nearly all the studies had missing data due to withdrawals or loss to follow-up. Two studies were rated as a high risk of bias as there was a lack of information regarding whether an appropriate analysis was used to correct for missing data and whether loss to follow-up was due to reasons related to participants' anxiety/depression symptom severity (Litvin et al., 2020; Przybylko et al., 2021).

Measurement of outcomes for most of the studies was conducted using online survey software that did not require interaction with the research team. Two studies were rated as having some concerns as there was no information regarding whether outcome assessors were aware of the intervention received by participants (Imamura et al., 2014) or whether their awareness was likely to affect the measurement of the outcome (Przybylko et al., 2021).

The main reason for studies being identified as having some concerns (n = 13) was because there was no clear information regarding whether the data was analysed in accordance with a pre-specified analysis plan which was finalised before unblinded outcome data was made available for analysis (RoB2 item 5.1). While nearly all studies included an analysis plan, or had a protocol published prior to the study taking place, it was rarely specified when, or even if, the plan had been finalised. A summary of the quality assessments for all studies included in the final analysis is given in Table 5.

3.3. Study characteristics

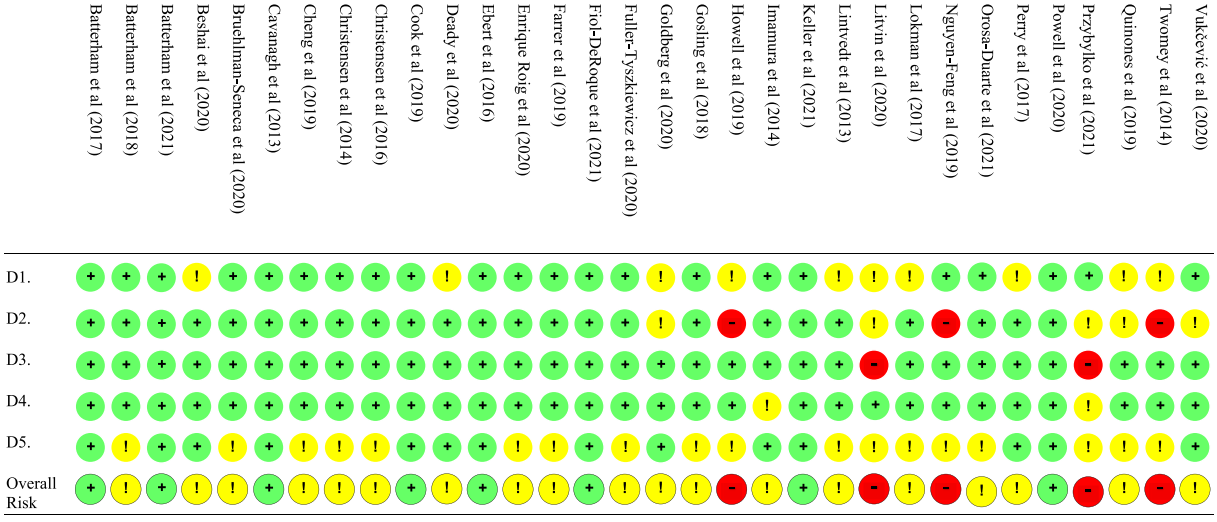
The total number of participants across all 32 studies was 20,249. The number of participants per study ranged from 83 to 2271, with a mean age of 34 years. The studies were conducted mainly in Western countries with most examining samples from Europe (n = 14) and Australia (n = 11). One study recruited participants worldwide (Beshai et al., 2020). Ten studies did not have any additional follow-up points past the primary end point which was often immediately post-intervention (Batterham et al., 2021; Beshai et al., 2020; Cavanagh et al., 2013; Enrique Roig et al., 2020; Fiol-DeRoque et al., 2021; Goldberg et al., 2020; Lintvedt et al., 2013; Orosa-Duarte et al., 2021; Quinones & Griffiths, 2019). The other studies had between one and three follow-up points ranging from 35 days to 15 months after randomisation. The average follow-up for all studies was 22 weeks with a large distribution (SD = 19.08). The study participants were mainly female with most studies (n = 23) identifying 70%, or more, of their participants as female. Only five studies had a majority of male participants ranging from 56.1% to 83.9% (Beshai et al., 2020; Deady et al., 2020; Imamura et al., 2014; Litvin et al., 2020; Quinones & Griffiths, 2019). Most studies reported outcomes relevant for both anxiety and depression (n = 22).

3.3.1. Depression

A total of 27 studies reported outcomes relating to depression, seven of which also reported incidence data which could be used for the primary outcome of this review. The instruments used to determine whether a diagnosis of depression was present post-intervention were varied and no study used the same method (Batterham et al., 2017; Cheng et al., 2019; Christensen et al., 2016; Cook et al., 2019; Deady et al., 2020; Imamura et al., 2014; Perry et al., 2017). Two studies used measures of symptom severity (PHQ-9) to determine onset, either participants scoring 10 or more (Batterham et al., 2017) or a computerised diagnostic algorithm based on total scores (Deady et al., 2020). The time of assessments ranged between 3-months and 15-months post randomisation.

All 27 studies reported depression symptom severity data relevant to the secondary outcome for this review. Most IMIs (n = 20) were internet-based interventions and primarily utilised techniques based on CBT

Table 5
Summary of risk of bias analysis.



D1 = Randomisation, D2 = Deviations from Intended interventions, D3 = Missing outcome data, D4 = Measurement of the outcome, D5 = Selection of the reported result

+ = low risk of bias, ! =Some concerns, - = high risk of bias

(Batterham et al., 2017, 2021, Cheng et al., 2019; Christensen et al., 2016; Cook et al., 2019; Imamura et al., 2014; Lintvedt et al., 2013; Perry et al., 2017), mindfulness (Goldberg et al., 2020), or a combination of the two (Deady et al., 2020; Farrer et al., 2019; Lokman et al., 2017) lasting between 27 and 84 days (M = 42, SD = 22).

3.3.2. Anxiety

A total of 29 studies reported outcomes related to anxiety, two of which also reported incidence data. Both these studies used assessment criteria exploring the presence of Generalised Anxiety Disorder (GAD), determined either via a score on the GAD-7 of 10 or more (Howell et al., 2019) or a MINI assessment interview (Christensen et al., 2014). One assessed the presence of anxiety post-intervention, three months after randomisation (Howell et al., 2019) and the other at follow-up, 6 months after randomisation (Christensen et al., 2014).

All 29 studies reported anxiety symptom severity data. Again, most of the IMIs were delivered via the internet (n = 20). The interventions primarily utilised techniques based on CBT (Christensen et al., 2014; Powell et al., 2020), mindfulness (Orosa-Duarte et al., 2021; Quinones & Griffiths, 2019), or a combination of CBT, positive psychology and systemic principles (Litvin et al., 2020). Interventions lasted between 14 and 84 days (M = 40, SD = 20).

3.4. Effectiveness

3.4.1. Primary outcome – incidence

The calculated Risk Ratios (RR) for each of the studies reporting incidence for depression and anxiety are given in Fig. 2. The relative risk for incidence of depression in the intervention groups compared to the control groups for seven studies was 0.67 (95% CI [0.48, 0.93], p = .02). A moderate degree of heterogeneity was present in this analysis (I^2 = 48%, p = .07). Sensitivity analyses were also conducted on studies reporting incidence of depression. First, universal prevention studies were excluded to examine whether this would improve the RR due to the study samples being part of a higher-risk group. Second, as several of the studies had participants who were already identified as having insomnia, these were excluded to see what effect this would have on the RR. Both analyses gave varying results from the main analysis (see Table 6).

Table 6
Comparison of Analyses for trials reporting incidence of depression: Relative Risks.

	N	RR	95% CI	I^2 (%)
Main Outcome				
All studies	7	0.67	0.48–0.93	48
Sensitivity Analyses				
Universal Excluded	5	0.57	0.41–0.80	36
Insomnia Studies Excluded	4	0.81	0.60–1.11	1

The relative risk for incidence of anxiety for two studies was 0.86 (95% CI [0.28, 2.66], p = .79) with a high degree of heterogeneity (I^2 = 76%, p = .04). Examination of the funnel plot indicated no sign of asymmetry (Fig. 3).

3.4.2. Secondary outcome – symptom severity

The SMDs and pooled effect size for the 27 studies which provided data regarding symptom severity for depression are given in Fig. 4. The

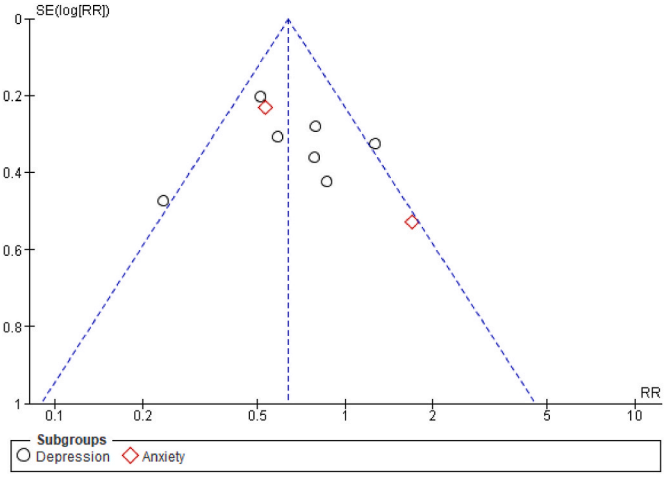


Fig. 3. Funnel Plot for studies reporting incidence.

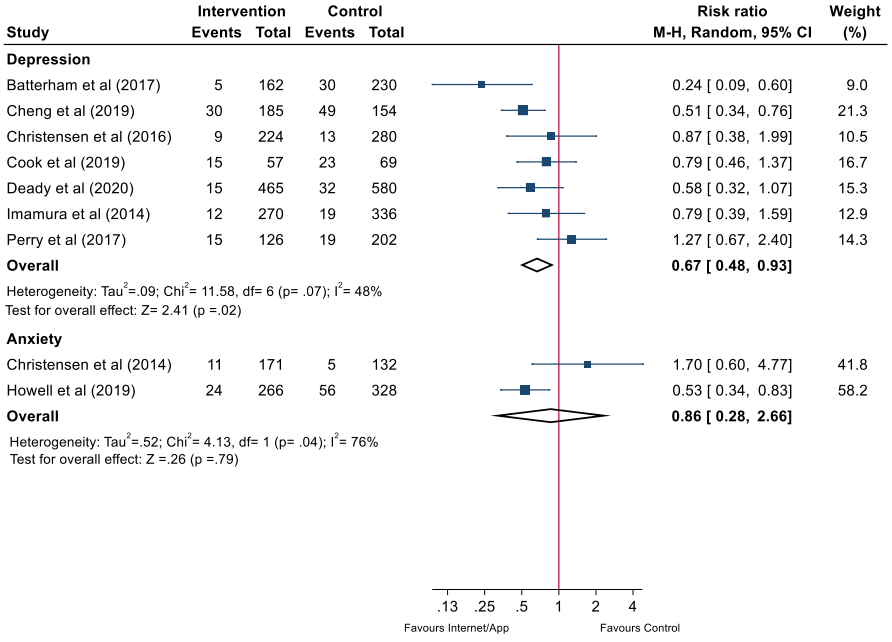


Fig. 2. Forest plot showing the effects of self-guided IMIs on incidence of anxiety and depression.

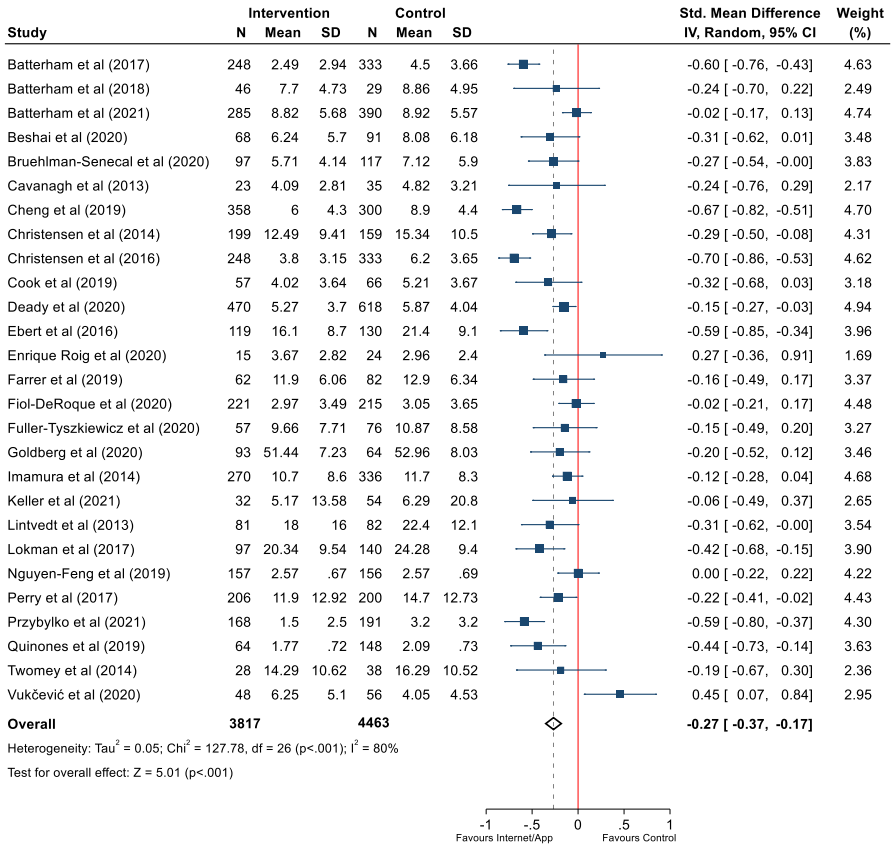


Fig. 4. Forest plot showing the effects of self-guided IMIs on depression symptom severity.

SMD of depression severity was −0.27 (95% CI [-0.37, −0.17], p < .001) indicating a lower level of symptoms in the intervention group relative to controls post-intervention. Overall, the analysis had a very high degree of heterogeneity ($I^2 = 80\%$, p < .001). A similar result was observed for the 29 studies reporting measures of anxiety symptom severity (Fig. 5). There was an overall SMD of −0.21 (95% CI [−0.31, −0.10], p < .001) with a lower level of anxiety symptoms in the intervention group relative to controls. Again, the analysis had a high degree of heterogeneity ($I^2 = 79\%$, p < .001). Examination of the funnel plots for each analysis indicated some slight asymmetry in the studies reporting anxiety symptom severity (Figs. 6 and 7).

4. Discussion

The aim of this systematic review and meta-analysis was to evaluate the efficacy of self-guided IMIs for preventing anxiety and depression by examining their impact on the reduction of incidence and symptom severity. This review examined the results from 32 randomised controlled studies mainly conducted in Western countries. Study quality was variable with five showing a high risk of bias.

In comparison to previous meta-analyses examining preventative IMIs (Deady et al., 2017; Sander et al., 2016), the current review has been able to capture data from a further five studies providing more information regarding whether self-guided IMIs can reduce the onset of depression (Batterham et al., 2017; Cheng et al., 2019; Cook et al., 2019; Deady et al., 2020; Perry et al., 2017). Our findings suggest that self-guided IMIs offer a reduction (33%) in the relative risk of receiving a diagnosis of depression compared to controls. A recent meta-analysis by Cuijpers et al. (2021) examined 50 randomised trials of (face-to-face) psychological interventions aimed at preventing the onset of depressive disorders and found an overall RR of 0.81 (95% CI [0.72, 0.91]). The results of the current study, therefore, indicate that self-guided IMIs may be at least of similar effectiveness to face-to-face psychological interventions for preventing depression. There are several factors, however, which need further consideration to assess the validity of this observation. First, the current review was only able to evaluate seven studies, most of which (n = 5) were identified as either selective or indicated prevention. This meant that the data obtained was mainly derived from participants who were at risk of depression or presenting with subthreshold symptoms and, therefore, more likely to be able to detect an effect. The sensitivity analysis excluding the two universal prevention studies (Imamura et al., 2014; Perry et al., 2017) supported this notion as it resulted in an improved RR and reduced heterogeneity. Even though indicated prevention designs may result in clearer estimates of effect it is imperative that the absence of the target disorder at baseline is established via use of diagnostic assessment tools. This ensures that the intervention being evaluated is preventative, rather than a form of treatment. While a diagnosis of depression was explicitly assessed in all seven studies, only three used a standardised diagnostic instrument at baseline (Batterham et al., 2017; Christensen et al., 2016; Cook et al., 2019). All the others used self-report instruments and only one study used a standardised diagnostic instrument to assess incidence at follow-up (Cook et al., 2019). This indicates there may be serious methodological limitations regarding how incidence was determined in most of the studies evaluated.

Another factor to consider is that three studies differed in their prevention approach by examining incidence of depression in people already meeting the criteria for insomnia (Batterham et al., 2017; Cheng et al., 2019; Christensen et al., 2016). The sensitivity analysis which removed these studies resulted in a reduced RR and a more homogenous sample. This suggests that the overall RR may be heavily influenced by data from the studies with participants who also had insomnia.

To summarise, though the current review indicates self-guided IMIs are effective at reducing incidence of depression this finding may be

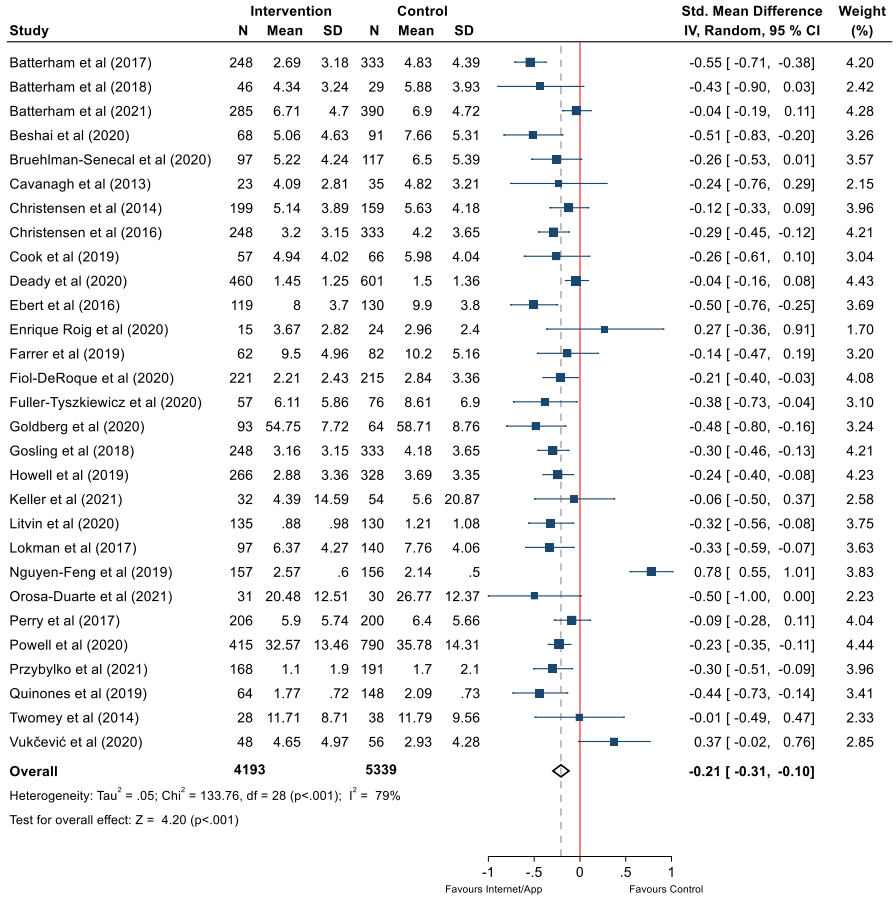


Fig. 5. Forest plot showing the effects of self-guided IMIs on anxiety symptom severity.

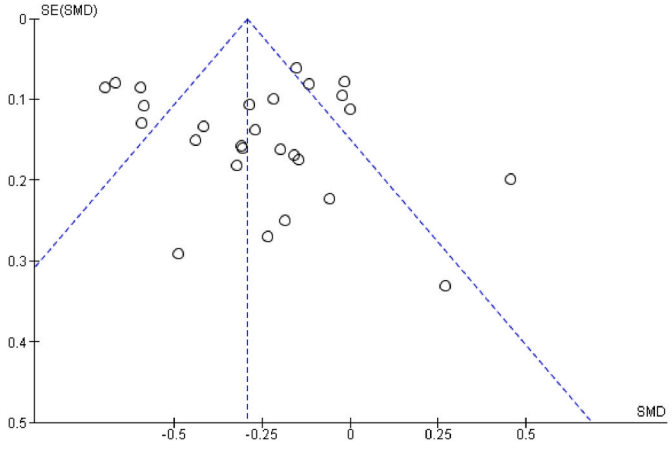


Fig. 6. Funnel Plot for studies reporting depression symptom severity.

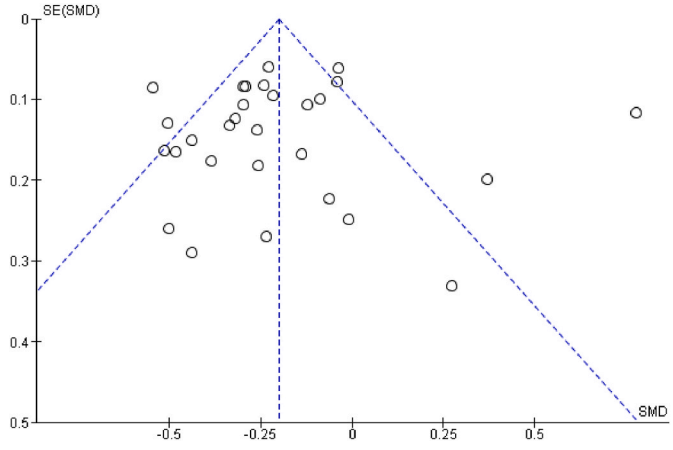


Fig. 7. Funnel Plot for studies reporting anxiety symptom severity.

more applicable to people with insomnia and those at risk or with subthreshold symptomatology (i.e., selective or indicated prevention). This is in accordance with the wider literature which has found that universal prevention interventions tend to be less successful (Topper et al., 2017). More data from universal prevention studies, and samples without co-morbid mental health problems is needed to clarify the results obtained in the current review. The need for an increase in the use of standardised diagnostic tools to determine incidence at follow-up is also indicated.

When looking specifically at anxiety, the effect of self-guided IMIs on incidence was less clear. The results of the meta-analysis show that the relative risk of receiving a diagnosis post intervention was not significant and was much lower than effects observed for depression (14%). This analysis, however, was only performed on two studies, one of which was considered to have a high risk of bias (Howell et al., 2019). Further, the study considered to be of higher quality did not find any significant differences between the intervention and control group (Christensen et al., 2014).

With regards to symptom severity, the IMIs examined showed a small, but significant, effect on depressive and anxiety symptoms with SMDs relative to controls of −.27 and −0.21 respectively. These findings are consistent with previous reviews (Deady et al., 2017; Sander et al.,

2016) and provide confirmation that self-guided IMIs can have a positive effect in reducing symptoms of anxiety and depression. Most studies were either selective (n = 11) or indicated (n = 10) prevention designs and while study quality varied, the weight of each study was relatively small due to the sheer volume of data analysed. One factor which was more variable within the symptom severity data, in comparison to incidence data, was the length of follow-up. Seven out of 27 studies examining depression symptom severity, for example, did not have any additional follow-up points after the intervention had been completed (Batterham et al., 2021; Beshai et al., 2020; Cavanagh et al., 2013; Enrique Roig et al., 2020; Fiol-DeRoque et al., 2021; Goldberg et al., 2020; Lintvedt et al., 2013; Quinones & Griffiths, 2019). Moreover, none of these studies reported symptom severity data past eight weeks and more than half (n = 4) only had data up to four weeks post-randomisation. Out of all 32 studies, 17 reported symptom severity data for a follow-up period of less than three months. This raises doubts over the long-term effects of the interventions examined and whether such a time frame would allow for an accurate assessment of a preventative effect.

Typically, preventative research comprises mainly of female participants as men are less likely to seek help or disclose problems related to their mental health (World Health Organization, 2021). One of the strengths of this review was that it captured more data from studies with mostly male participants. There was, however, still a considerable difference between genders with most studies having over 70% of their participants as female. Nevertheless, as anxiety and depression are disorders which are more common in women (Altemus et al., 2014), it can be argued that the sample in this review is still a good representation of the population expected to benefit from these particular interventions (Bekker & van Mens-Verhulst, 2007; Robichaud et al., 2003).

Another relative strength for the current review was the inclusion of studies which referenced improvement of protective factors (such as emotional/mental well-being) or a reduction of risk factors (such as rumination or worry) when screening abstracts. This addressed some of the limitations with previous meta-analyses which did not include studies of well-being or general psychological distress thus limiting the range of prevention techniques under examination (Deady et al., 2017). Casting such a 'wide net', however, is likely to have contributed to the high degree of heterogeneity observed in analyses of symptom severity. While we tried to account for these differences to some extent by using a random effects analysis, the high level of heterogeneity means the observed effect sizes for the secondary outcome of this review should still be interpreted with caution.

4.1. Limitations

There are several limitations with this review which should be considered when interpreting the results. First, despite the inclusion of several studies reporting non-significant or unexpected results, this review did not search for additional articles in grey literature and only included full-text articles which were written in English. As a result, an element of publication bias is likely (Ropovik et al., 2021), though informal inspections of funnel plots indicated that this may only be the case for studies reporting anxiety symptom severity. It should also be noted that there was a high level of variability in the studies included in this review and there are several sources of heterogeneity within the data in addition to those which have already been highlighted. While most interventions were based on aspects of CBT and mindfulness, other intervention types were also included and many of the IMIs used a combination of different approaches in their intervention. There were also a variety of different control groups. We tried to account for this by selecting data from similar controls when studies used three or more groups, however this still varied between waitlist type controls (i.e., with no specified intervention) and placebo control interventions. Lastly as the data analysed was taken from the first follow-up point, the results obtained are only representative of short-term outcomes for differences in symptom severity (a maximum of three months post randomisation) and the medium to long term for incidence (between six and 18 months).

The limitations of the current data set in this review have shown that there is still a considerable lack of robust, high-quality studies examining the efficacy of preventative self-guided IMIs which report incidence. The use of indicated prevention designs combined with a lack of standardised diagnostic tools means it is sometimes questionable whether the intervention is preventative due to participants often presenting with high levels of symptomatology indicative of anxiety and/or depression; an issue which was also apparent during previous reviews (Deady et al., 2017). This is something which future research needs to continue to try and address. It remains imperative that indicated, and possibly even selective, prevention studies explicitly test whether participants meet the criteria for a diagnosis of the identified disorder at baseline and that the use of standard diagnostic tools is prioritised. Further, longer follow-up periods are needed to help evaluate whether any changes observed post-intervention are being maintained and provide a clearer indication of any preventative effects.

5. Conclusions

The need to identify effective ways for preventing mental health problems is now more apparent than ever. Self-guided IMIs provide an opportunity for interventions to be accessed more widely at a reduced cost. The results of this meta-analysis show that self-guided IMIs appear to be effective at preventing incidence of depression, though this finding may be more applicable for people with co-morbid mental health problems (i.e., insomnia) as part of an indicated, or selective, prevention approach. Self-guided IMIs also appear to be effective in reducing symptoms of anxiety and depression in the short-term, though their effect on preventing incidence of anxiety is less apparent. This review has highlighted that a significant limitation in the prevention literature examining self-guided IMIs is the heavy reliance on symptom measures. Future research needs to prioritise the use of standard diagnostic measuring tools to ensure incidence of the identified disorder is more appropriately assessed. Longer follow-up periods are also needed to confirm whether the observed benefits of self-guided IMIs are being maintained. Future reviews could help address some of the limitations identified in this study by including more data from grey literature and reducing the impact of heterogeneity.

CRediT authorship contribution statement

Daniel Edge: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft. **Edward R. Watkins:** Conceptualization, Supervision, Resources, Writing – review & editing. **Jenny Limond:** Supervision, Resources, Writing – review & editing. **Jane Mugadza:** Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brat.2023.104292.

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