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Review article

# Digital Interventions for Anxiety and Depressive Symptoms in Adolescence: Systematic Review

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A B S T R A C T

The rising prevalence of anxiety and depression among adolescents highlights the need for accessible intervention solutions. The objectives of this systematic review were to (1) identify existing digital interventions for adolescent depression and anxiety, (2) assess the promise of those interventions, and (3) identify characteristics of promising interventions. Six databases (PubMed, PsycINFO, Web of Science, Embase, MEDLINE, and Google Scholar) were used to conduct searches between September and October 2023. The searches were re-run in June 2024. Twenty studies met the criteria for inclusion, leading to the identification of 17 distinct interventions for analysis. The promise of the interventions was assessed through their effectiveness, the Reach, Effectiveness, Adoption, Implementation, Maintenance framework dimensions, and risk of bias. The evaluation of interventions' promise deemed three studies as "Quite Promising," six as "Slightly Promising," four as "Inconclusive Promise," and seven as "Not Promising." All promising interventions somewhat met the Reach, Effectiveness, Adoption, Implementation, Maintenance dimensions. Variability was observed in Template for Intervention Description and Replication characteristics, including rationale, intervention provider, length and frequency of intervention, and retention. Factors that potentially contribute to the success or limitation of digital mental health interventions among adolescents are discussed. The review underscores the need to enhance the methodological rigor and to evaluate and report the real-world impact of interventions to ensure they benefit a broader demographic of young people.



**IMPLICATIONS AND CONTRIBUTION**

This review looked at the effectiveness and real-world impact of online programs designed to help adolescents with low mood and anxiety. The results showed that most studies do not reach enough adolescents from different backgrounds, making it difficult to evaluate how the interventions would work outside of a research study.

The increasing prevalence of mental health disorders among adolescents, particularly anxiety and depression, constitutes a significant public health concern that requires attention and innovative intervention strategies. A recent study indicated that approximately one in 10 young people worldwide, aged between 5 and 25 years, are likely to live with a mental health disorder [1]. UNICEF's report has highlighted similar findings, further stating that anxiety and depression are among the most common mental health disorders in this age group [2]. The consequences of persisting mental health problems are profound and far-reaching. Research has shown that these mental health

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problems, when left untreated, can continue into adulthood and negatively impact education, employment, quality of life, and physical health and may lead to substance misuse [3–7].

The upward trend in the prevalence of mental health problems may have contributed to increasingly long waiting times for public adolescent mental health services [8]. In the United Kingdom, by the end of 2023, up to 90% of those aged 18 years or younger waited between 45 and 250 days for treatment after referral [9–11], highlighting a critical gap between the increasing demand for mental health services and the scarcity of health care professionals [12,13]. However, despite the growing demand, a considerable number of adolescents, between 60% and 70% [14–17], hesitate to seek help. This is often due to stigma, feelings of embarrassment, or concerns over confidentiality [18–20].

In response to these challenges, digital mental health interventions have emerged as valuable tools in addressing anxiety and depression, among other mental health problems [21]. The integration of digital technology into adolescents' lives is evident, as recent data shows that over 90% of children own a mobile phone by the age of 14 years [22,23]. These digital interventions provide unique advantages, such as easy access, flexibility, anonymity, and the ability to reach a broader spectrum of individuals simultaneously [24], all of which are essential for offering immediate support. These features align well with adolescents' preferences for privacy [25] and independence [26] when seeking support, making digital solutions very well-suited for improving accessibility and inclusivity. Digital mental health support could improve adolescents' mental health literacy, equipping them with the skills needed to better self-manage symptoms and recognize when professional help is required [27,28]. This approach may alleviate the burden on mental health services but at the same time facilitate a smoother transition from unguided to professionally supported health care treatments for those with persistent symptoms. In addition, these interventions offer a potentially cost-effective approach to sustainably manage the growing demand for mental health services [29].

Existing reviews on digital mental health interventions have primarily focused on evaluating their effectiveness [30,31]. These reviews face challenges due to variable outcomes and concerns over diverse research methodologies, leading to reports of inconclusive and inconsistent findings. This highlights the need for more rigorous evaluation and standardized reporting that would help identify effective digital mental health interventions [32–35]. The Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework [36–38] and Template for Intervention Description and Replication (TIDieR) checklist (see Appendix A) [39] could serve as tools for evaluating research quality and real-world impact and for identifying gaps in the design, delivery, and evaluation of those interventions. The RE-AIM framework provides a multifaceted approach to evaluating health interventions through its focus on impact and sustainability. It considers whether interventions are not only effective but also broadly applicable and sustainable. The TIDieR checklist, on the other hand, aims to enhance intervention replication, transparency, and comparability by offering a structured template for intervention reporting. It promotes a thorough description of an intervention's rationale, materials, procedures, delivery, and evaluation processes. Therefore, adopting these tools into research practices could amplify the clarity, quality, and consistency of reporting, facilitating better replicability and scalability, thereby addressing the reproducibility challenges observed within psychological sciences [40].

There is a need to review the characteristics of interventions considered promising with a focus on the evaluation of real-world implications of digital interventions for anxiety and depression. In this study, "promising" refers to the potential effectiveness and real-world applicability of an intervention, evaluated through its effectiveness, reach, adoptionRE-AIM, in addition to an assessment of methodological study biases. In addition, the TIDieR checklist is used for detailed examination of intervention characteristics. While similar to Wright et al.'s [41] review, which also examined characteristics of mental health interventions, our review expands on this work by adopting and refining Brigden et al.'s [42] classification of promising interventions through the RE-AIM framework dimensions. Thus, this current systematic review aims to bridge existing gaps by offering insights into the characteristics of promising digital mental health interventions and evaluating their real-world impact.

## Methods

### *Registration*

This systematic review was registered with the Prospective Register of Systematic Reviews database before conducting the extensive search (CRD42023433863), and it adhered to the Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines [43].

### *Eligibility criteria*

This systematic review was conducted as part of the Sleep Well Study (https://doi.org/10.1186/ISRCTN14480620), which targets insomnia, anxiety, and depressive symptoms in British adolescents aged between 14 and 18 years. Findings from this review informed the selection of 2 digital interventions addressing the mental health component of the study, which are currently being used alongside other interventions targeting sleep. For this review, the following eligibility criteria were adopted.

1. Studies focusing on adolescents with reported mean age between 14 and 18 years were included. This age range was decided upon the reported peak age (14.5 years) for the onset of mental health disorders [44] and the standard practice of providing mental health services to individuals within the child and adolescent services until the age of 18 years [45]. This age group represents a critical period for early intervention, where adolescents can engage independently, and symptoms can be addressed before they become more persistent.
2. Studies focusing on the general adolescent population, as well as those specifically targeting individuals exhibiting anxiety and/or depressive symptoms at baseline, were included.
3. Research that included preintervention and postintervention data focusing on anxiety and/or depression.
4. Digital interventions aimed at alleviating symptoms of anxiety and/or depression in adolescents. Digital interventions (e.g., mobile apps, Web sites, videogames) were defined as mental health interventions that could be delivered directly to the individual through digital devices such as smartphones, laptops, or tablets. However, group therapy, psychotherapy (e.g., telephone-based interventions, videoconferencing), and

any interventions delivered through social media were excluded.
5. Self-guided digital interventions that provided minimal human support (e.g., technical support) during the treatment phase were included. However, studies where parents received concurrent interventions or where mental health support was provided to participants during the intervention phase were excluded. Eliminating such additional support ensures that outcomes can be attributed more directly to the digital interventions itself, facilitating a more systematic and reliable comparison across interventions.
6. Randomized controlled trials (RCTs), clinical trials, feasibility, and pilot trials evaluating interventions' effectiveness with quantitative or mixed research methods were included. Solely qualitative papers that were not a part of a trial were excluded.
7. Academic and gray literature published between January 2013 and June 2024, if available in English, were included. This time frame aligns with the World Health Organization's (WHO) 2013 Mental Health Action Plan, which highlighted mobile health technologies as a means of providing accessible and inclusive mental health services, potentially influencing the surge in digital mental health interventions [46].

### *Search strategy*

The comprehensive searches were conducted between September and October 2023 in 6 databases (PubMed, PsycINFO, Web of Science, Embase, MEDLINE, Google Scholar) [47] and were specified by population (e.g., adolescen*, youth, teen*), intervention (e.g., "automated intervention," "early intervention," digital mental health*), medium (e.g., mobile app*, online*, web*), presenting problem (e.g., mental health*, anxi*, depress*), and study design (RCT*, pilot, feasibl*). Google Scholar was included to capture both peer-reviewed and gray literature [48]. The search was re-run before submission (June 10, 2024). Search syntax has been modified for each database, full search strategy can be found in Appendix B.

### *Selection process*

All search results were exported to Rayyan software [49] for removal of duplicates and screening. The review process began with 2 independent reviewers (P.K. and M.J.) screening titles and abstracts for initial eligibility. Subsequently, one reviewer (P.K.) conducted a detailed full-text screening, with the second reviewer (M.J.) independently assessing randomly selected 10% of these papers, including those highlighted by the first reviewer (P.K.) due to concerns around eligibility. Any discrepancies between the 2 reviewers (P.K. and M.J.) were resolved through discussion.

### *Data extraction and synthesis*

*Study characteristics.* Data extraction was conducted using Microsoft Excel, with the first reviewer (P.K.) extracting a broad spectrum of study characteristics, including author, publication year, country, title, study design, participants' demographic characteristics, number of participants, focus of the study (decreasing symptoms of anxiety, depression or both), medium of intervention delivery (smartphone app, Web site), intervention name, amount of support provided during intervention, intervention type (tailored, generic), components of the intervention (description, key features, modules, theoretical basis), length of treatment phase, frequency of the intervention, measures used to assess anxiety and depression, symptom levels at baseline, post-treatment symptom levels, study design (RCT, pilot), methods (quantitative, mixed methods), setting (school-based, not school-based), accessibility (freely available, paid, prescription), experience and engagement data (attrition rate, interviews), as well as information necessary to assess risk of bias and RE-AIM framework dimensions. The second reviewer (M.J.) then verified the accuracy of these data.

*Data synthesis.* Following the evaluation of effectiveness and risk of bias, studies were first classified as "not promising," "inconclusive promise," or considered for further assessment. A narrative synthesis was then used to assess the RE-AIM dimensions [36,37] for the remaining studies, contributing to their final categorization as "slightly promising" or "quite promising." This integrated analysis informed a comprehensive criterion for evaluating the promise of each intervention ("quite promising," "slightly promising," "inconclusive promise," or "not promising"). A description of these categories can be found in Table 1. Throughout this process, instances of missing data, especially in relation to the RE-AIM framework, were reported transparently.

After the assessment of the RE-AIM dimensions, the narrative synthesis was further used to delve into the specific characteristics of the interventions. This involved a detailed examination using the TIDieR checklist [39], which helped to describe and understand the complex aspects of each intervention that contributed to their success or limitation. In addition, the synthesis included data on participants' engagement and evaluation of the interventions, which were extracted from the included studies. This enriched the understanding of their practical implications. Due to the anticipated variability in interventions (different theoretical basis, varied instruments used), a meta-analysis was not feasible.

### *Quality assessment*

The risk of bias assessment was conducted using standardized tools: RoB 2: A revised tool for assessing risk of bias in randomized trials [50] and Study Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group [51]. Each assessment, initially performed by the first reviewer (P.K.), was later verified by the second reviewer (M.J.), who checked the responses for consistency. Any discrepancies between the 2 reviewers (P.K. and M.J.) were resolved through discussion. Published protocols were examined whenever available.

## Results

### *Study selection*

The database searches yielded a total of 4,958 papers once duplicates were removed. After a thorough screening process, 20 studies, including those identified from the re-run of searches, were deemed eligible for inclusion. These studies collectively resulted in the identification of 17 distinct interventions for analysis, with three studies referring to the "stressbusters" intervention and 2 studies to the "spark" intervention. The detailed study selection process was depicted in the Prisma flow diagram, as shown in Figure 1 [43].

**Table 1**
Description of interventions' promise categories

| Category | Overview | Description |
|---|---|---|
| Quite Promising | • Low risk of bias<br>• Effective<br>• Somewhat met the RE-AIM dimensions. | Effective interventions with low risk of bias that somewhat met the RE-AIM dimensions were considered **quite promising**. |
| Slightly Promising | • Low risk of bias/some concern<br>• Effective<br>• Somewhat met the RE-AIM dimensions/ didn't meet the RE-AIM dimensions. | • Effective interventions that had some risk of bias but met the RE-AIM dimensions were considered **slightly promising**.<br>• Effective interventions that had low/some risk of bias but didn't meet the RE-AIM dimensions were also considered **slightly promising**.<br>• Pilot or feasibility trials with preliminary evidence of potential effectiveness that had low/ some risk of bias, regardless of whether they met the RE-AIM dimensions, were considered **slightly promising**. |
| Inconclusive promise | • Pilot or feasibility trial<br>• No preliminary evidence of potential effectiveness | Pilot or feasibility trials without preliminary evidence of potential effectiveness, regardless of whether they met the RE-AIM dimensions, were considered having **inconclusive promise**. |
| Not Promising | • High risk of bias<br>• Ineffective<br>• Full RCT | Full RCT studies that were either ineffective or had a high risk of bias, regardless of whether they met the RE-AIM dimensions, were considered **not promising**. |

RCT = randomized controlled trial; RE-AIM = Reach, Effectiveness, Adoption, Implementation, Maintenance.

*General study details and promise evaluation*

Of 20 included studies, 14 were RCTs [52–65], 4 were pilot studies [66–69], and 2 were feasibility studies [70,71]. Twelve studies were conducted in Europe [55–62,65,68–70], 5 studies were conducted in North America [63,64,66,67,71], 2 studies were conducted in Australia [53,54], and one study was conducted in Asia [52]. All interventions had anxiety and depression either as a primary or secondary outcome except for "breathe" [67] and "Cognitive Bias Modification" [60], which targeted anxiety only as well as "positive psychology intervention" [65], which focused solely on depression. The detailed overview is presented in Table 2.

*Population characteristics*

There was a total of 6,503 participants at baseline with sample sizes ranging from 60 to 2,452. Participants were aged between 11 and 21 years. Most of the studies only reported the number of females participating in the study, which came to 4,388 (67.5%) girls overall. Only 11 studies reported demographic characteristics other than age and/or gender [53,57,63–71]. The "positive psychology intervention" study was the only one reporting on participants' socioeconomic status finding that most participants (71.8%) were of high socioeconomic status [65]. One study reported on participants' nationality (82.6% Dutch) [57], and three studies reported on parents' education level noting that most held higher education degrees [57,65,71]. The "Breathe" [67] study specified the geographic region of residence in Canada (51% residing in the Canadian Prairies) and the "Spark v2.1" [64] described the population density of participants' areas of residence, with 87.5% living in an urban area. Seven studies that included data on participants' ethnicity reported the following: 70.1% White/White British, with the remaining individuals being of European, Asian, Native American, Black, or mixed backgrounds [63,64,66,68–71]. Two studies additionally reported that approximately 30% of individuals identified as being part of the LGBTQI community [53,63].

*RE-AIM framework*

All "quite promising" [52,61,63] and "slightly promising" [53,54,62,64,66,70] interventions somewhat met the RE-AIM dimensions. Although reporting was insufficient to confirm the full scope of all criteria, elements of reach, effectiveness, adoption, implementation, and maintenance were present to varying degrees across the interventions. A detailed narrative assessment of the RE-AIM dimensions can be found in Appendix C.

*Promise evaluation*

The evaluation of interventions' promise deemed 3 studies as "quite promising" [52,61,63], 6 studies as "slightly promising" [53,54,62,64,66,70], 4 studies as "inconclusive promise" [67–69,71], and 7 studies as "not promising" [55–60,65]. All promising interventions demonstrated effectiveness in reducing symptoms of anxiety and/or depression, except "We Click" [53]. Although "We Click" did not significantly reduce these symptoms, it effectively enhanced adolescents' well-being and help-seeking behaviors, thereby supporting its inclusion in the "slightly promising" category. A comprehensive overview of the promise assessment is provided in Table 3, and a detailed risk of bias evaluation is provided in Appendix D.

*Description of intervention according to the TIDieR checklist*

The following section explored the characteristics of interventions categorized as "quite promising" and "slightly promising" in accordance with the TIDieR checklist. Given that all the examined interventions were delivered online, the "location (where)" aspect of the checklist has been omitted, and any changes to the setting of intervention delivery were included in the "mode of delivery" element. The detailed overview is provided in Table 4.

*Rationale/theory (why).* Distinct theories underpin the examined interventions. Four studies incorporated elements of cognitive behavioral therapy (CBT) [61], with three of these additionally integrating behavioral activation [52,64] and social learning theory [53]. In addition, the remaining 5 interventions were founded on 4 separate principles: mindfulness [62,66], positive psychology [54], behavioral activation [63], and growth mindset theory [63,70].

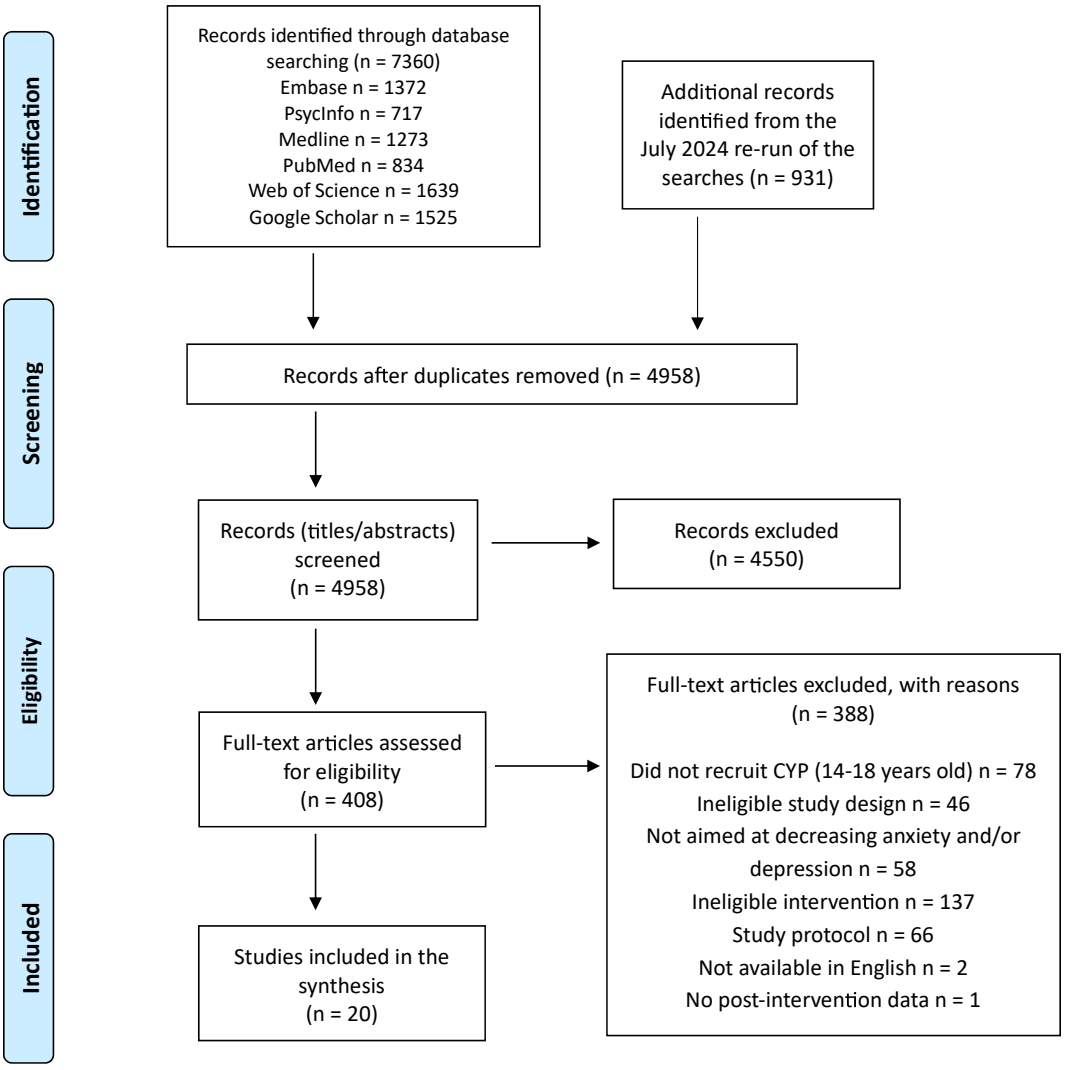


**Figure 1.** PRISMA flow diagram.

*Materials and procedures (what).* Various strategies have been used to engage adolescents with digital interventions. All interventions, except for "We Click" [53], "CARE" [66], and "Spark v2.1" [64], incorporated videos to convey information. Stories featuring either real or fictional young characters were integrated within the "Grasping the Opportunity" [52], "Project YES" [63], and "An Enhanced Psychological Mindset Session" [70] interventions. "Stressbusters" [61] and "Spark v2.1" [64] also used animations to present the interventions' content, with "Spark v2.1" implementing a reward system. "Grasping the Opportunity" [52], "Stressbusters" [61], and "Spark v2.1" [64] further enhanced user experience through interactive elements. In a unique approach, "We Click" [53] focused on skill development, including problem-solving, conflict resolution, and goal setting, through its interactive storytelling using various characters. On the other hand, "CARE" [66] and "Tita" [62] offered guided mindful exercises.

*Intervention provider (who).* Due to the nature of the eligibility criteria, minimal to no human support was provided during the intervention phase of the studies. Participants in the "Grasping the Opportunity" intervention received technical support whenever necessary [52]. In addition, the research team was present during the "Enhanced Psychological Mindset Session" intervention to ensure adherence to the protocol [70]. However, in both instances, therapeutic support was not provided. The remaining interventions offered no support during this stage. All studies, except the "Enhanced Psychological Mindset Session" [70], "Project YES" [63], and "Stressbusters" [61], included reminders intended to encourage participant engagement with the interventions. The frequency of these reminders varied from daily to monthly.

*Mode of delivery (how).* Except for "An Enhanced Psychological Mindset Session" [70], all interventions were designed to be self-paced and accessible anytime. However, "An Enhanced Psychological Mindset Session" [70] and "Stressbusters" [61] were self-administered in a classroom during school hours. Participants assigned to the "Grasping the Opportunity" intervention were specifically encouraged to engage with it during study periods [52]. Among all the interventions, 4 were delivered through a

**Table 2**
General study characteristics, population characteristics, targeted area, and findings

| Intervention name (country) | Design | Sample (mean age/age range) | Conditions | Targeted area | Outcome measures | Measurement time points | Findings[a] | Availability |
|---|---|---|---|---|---|---|---|---|
| Quite Promising | | | | | | | | |
| Grasp the Opportunity (China) [52] | RCT | $N = 257$ (14.63) with mild-to-moderate depressive symptoms | 1. Grasp the Opportunity<br>2. Attention control | *Primary outcomes:* depressive symptoms; *Secondary outcomes:* depression, anxiety, stress, behavioral health | *Anxiety and Depression:* DASS21 *Depressive symptoms:* CESD-R | Baseline, 4 months, 8 months, 12 months | Significant reductions at 12-month follow-up were found in the intervention group for depressive symptoms (effect size: Cohen's $d = -0.36$) and at 8-month follow-up for depression, anxiety, and stress ($d = -0.28$, $d = -0.35$, $d = -0.27$, respectively). | Not found |
| Project YES (The United States) [63] | RCT | N = 2,452 (13–16) with elevated depressive symptoms | 1. ABC Project<br>2. Project Personality<br>3. Supportive Therapy | *Primary outcomes:* Depressive symptoms; *Secondary outcomes:* Anxiety symptoms, COVID-19-related trauma symptoms, agency, hopelessness, restrictive eating | *Anxiety:* GDA-7 *Depression:* CDI-SF | Baseline, post-test, 3 months | Statistically significant reductions at 3-month follow-up were found in the BA-SSI (effect size: Cohen's $d = 0.18$) and GM-SSI group ($d = 0.18$) for depressive symptoms. Statistically significant improvements were also observed in anxiety for GM-SSI group ($d = 0.10$) at 3-month follow-up, no significant changes were found in anxiety symptoms for BA-SSI ($d = 0.02$). | Free access online: https://www.schleiderlab.org/YES.html |
| Stressbusters (The United Kingdom) [61] | RCT | N = 112 (12–16) with mild-to-moderate depressive symptoms | 1. Stressbusters<br>2. Waitlist | *Primary outcomes:* Depressive symptoms; *Secondary outcomes:* Anxiety symptoms | *Anxiety:* SCARED *Depression:* MFQ | Baseline, post-test, 3 months, 6 months | Statistically significant improvements were observed for both anxiety and depressive symptoms at postintervention (effect sizes: Cohen's $d = 0.82$, $d = 0.41$, respectively). | Available to buy online. |
| Slightly Promising | | | | | | | | |
| CARE (The United States) [66] | Pilot | $N = 80$ (14.01) with moderate levels of rumination | 1. CARE app | *Primary outcomes:* Rumination, worry, depressive, and anxiety symptoms | *Anxiety:* MASC2 *Depression:* CDI | Baseline, post-test, 6 weeks, 12 weeks | Significant reductions were found in rumination, and anxiety, which persisted throughout the 12-week follow-up (effect sizes: Cohen's $d = 0.35$, $d = 0.42$, respectively). No statistically significant changes were found for worry and depressive symptoms ($d = 0.27$, $d = 0.16$, respectively). No control group. | Not found |

**Table 2**
Continued

| Intervention name (country) | Design | Sample (mean age/age range) | Conditions | Targeted area | Outcome measures | Measurement time points | Findings[a] | Availability |
|---|---|---|---|---|---|---|---|---|
| WeClick (Australia) [53] | RCT | N = 193 (14.82) | 1. WeClick<br>2. Waitlist | *Primary outcomes:* Depressive symptoms; *Secondary outcomes:* Anxiety, psychological distress, well-being, help-seeking, social self-efficacy, social support, belongingness | *Anxiety:* SCAS *Depression:* PHQ-A | Baseline, 4 weeks, 12 weeks | Significant improvements were observed at 4-week post-test in the intervention group in well-being and intentions to seek help (effect sizes: Cohen's $d = 0.37$ and $d = 0.36$, respectively). Unlike well-being, help-seeking intentions sustained at 12-week follow-up. No differences between groups were found for anxiety and depression. | Available only in Australian schools via the Black Dog Institute's Smooth Sailing digital services. |
| Bite Back (Australia) [54] | RCT | N = 235 (15.4) | 1. Bite Back<br>2. Control | *Primary outcomes:* Depression, anxiety, stress, well-being | *Anxiety and Depression:* DASS21 | Baseline, post-test | Statistically significant reductions in depression and stress as well as improvement in well-being were observed in the intervention group (effect sizes: Cohen's $d = -0.45$, $d = -0.43$, $d = 0.39$, respectively) at the 6-week follow-up. No statistically significant changes were reported for anxiety ($d = -0.06$) at the postintervention mark. | Free access online: https://www.biteback.org.au/MentalFitnessChallenge |
| An Enhanced Psychological Mindset Session (The United Kingdom) [70] | Feasibility RCT | N = 80 (16.63) | 1. Mindset session<br>2. Control | *Primary outcomes:* Personality mindset, psychological flexibility, self-compassion, self-esteem, low mood and anxiety | *Anxiety and Depression:* RCADS-25 | Baseline, post-test, 4 weeks, 8 weeks | Statistically significant reductions were found in total RCADS-25 score, anxiety, and depression subscales in the intervention group, which persisted throughout the 8-week follow-up (effect sizes: Cohen's $d = -0.35$, $d = -0.58$, $d = -0.23$, respectively). | Not found |
| Tita (Finland) [62] | RCT | N = 1,349 (mostly 16 −19) | 1. Tita<br>2. Waitlist | *Primary outcomes:* Anxiety, depressive symptoms, school burn-out, psychological quality of life; *Secondary outcomes:* Satisfaction with life, mindfulness, self-compassion, sleep problem, happiness | *Anxiety:* GAD-7 *Depression:* R-BDI | Baseline, post-test, 3 months | Significant reductions were found in anxiety, depression, and sleep problems (effect sizes: Cohen's $d = 0.26$, $d = 0.15$, $d = 0.11$, respectively), increase in psychological quality of life, mindfulness, self-compassion, and happiness ($d = 0.16$, $d = 0.15$, $d = 0.14$, $d = 0.22$, respectively). | Not found |

(*continued on next page*)

**Table 2**
Continued

| Intervention name (country) | Design | Sample (mean age/age range) | Conditions | Targeted area | Outcome measures | Measurement time points | Findings[a] | Availability |
|---|---|---|---|---|---|---|---|---|
| Spark v2.1 (The United States) [64] | RCT | N = 160 (16.89) | 1. Spark v2.1 and v.2.2<br>2. Control | *Primary outcomes:* Depressive symptoms; *Secondary outcomes:* Anxiety symptoms | *Anxiety:* GAD-7<br>*Depression:* PHQ-8 | Baseline, post-test | Statistically significant reductions were found in individuals with mild-to-severe symptoms of depression (effect size: Cohen's $d = -0.16$). Small changes in anxiety symptoms were found, however, no statistical significance was provided ($d = -0.35$). | Request access to new demo version: https://www.bighealth.com/spark-direct |
| Potentially Promising | | | | | | | | |
| Breathe (Canada) [67] | Pilot RCT | N = 70 (15.3) with mild-to-severe anxiety | 1. Breathe<br>2. Control | *Primary outcomes:* Anxiety; *Secondary outcomes:* Minimal Clinically Important Difference | *Anxiety:* MASC2 | Baseline, 8 weeks | Small changes in anxiety scores were found (effect size: Cohen's d = 0.07). No statistically significant differences between groups were reported. | Not found |
| Spark v2.0 (The United States) [71] | Feasibility RCT | N = 60 (17.91) | 1. Spark v2.0<br>2. Control | *Primary outcomes:* Depression and anxiety symptoms | *Anxiety:* GAD-7<br>*Depression:* PHQ-8 | Baseline, post-test | Small changes in depression and anxiety scores were found (effect size: Cohen's $d = 0.20$, $d = -0.18$, respectively). No statistically significant differences between groups were reported. | Request access to new demo version: https://www.bighealth.com/spark-direct |
| Stressbusters (12-month follow-up) (The United Kingdom) [68] | Pilot RCT | N = 139 (Intervention group: 14.9) with low mood/ depression | 1. Stressbusters<br>2. Attention control | *Primary outcomes:* Depression; *Secondary outcomes:* Mood, anxiety, quality of life | *Anxiety:* SCAS<br>*Depression:* BDI, MFQ | Baseline, post-test, 4 months, 12 months | Small changes in anxiety and depression scores were found (effect sizes: Cohen's $d = 0.21$, $d = 0.05$, respectively). No statistically significant differences between groups were reported. | Not found |
| Stressbusters (4-month follow-up) (The United Kingdom) [69] | Pilot RCT | N = 91(intervention group: 15.5) with low mood/ depression | 1. Stressbusters<br>2. Attention control | *Primary outcomes:* Depression; *Secondary outcomes:* Mood, anxiety, quality of life | *Anxiety:* SCAS<br>*Depression:* BDI, MFQ | Baseline, 4 months, 12 months | Mean scores for depression and mood decreased and quality of life increased at 4-month follow-up. However, there was no statistical significance provided. Small changes in anxiety and depression scores were found (effect sizes: Cohen's $d = 0.30$, $d = 0.00$, respectively). | Not found |

**Table 2**
Continued

| Intervention name (country) | Design | Sample (mean age/age range) | Conditions | Targeted area | Outcome measures | Measurement time points | Findings[a] | Availability |
|---|---|---|---|---|---|---|---|---|
| Not Promising | | | | | | | | |
| CBM-I (The Netherlands) [55] | RCT | N = 119 (15.68) with scores on SCARED >16 and CDI >7 | 1. Scenario training<br>2. Picture-word training<br>3. Control | *Primary outcomes:* Anxiety and depressive symptoms; *Secondary outcomes:* Interpretation bias, stress reactivity, self-esteem, worry, rumination, emotional and behavioral problems | *Anxiety:* SCARED *Depression:* CDI | Baseline, post-test, 3 months, 6 months | Small changes in anxiety and depression scores were found for both scenario (effect sizes: Cohen's $d = 0.02$, $d = 0.22$, respectively) and picture-word conditions ($d = 0.21$, $d = 0.16$, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | Not found |
| ABM (The Netherlands) [56] | RCT | N = 108 (14.45) with scores on SCARED >16 and CDI >7 | 1. Visual search (VS) training<br>2. VS placebo<br>3. Control | *Primary outcomes:* Anxiety and depressive symptoms; *Secondary outcomes:* Self-esteem, perseverative negative thinking, social-emotional and behavioral problems, stress reactivity | *Anxiety:* SCARED *Depression:* CDI | Baseline, post-test, 3 months, 6 months | Small changes in anxiety and depression were found in the control group over VS training (effect sizes: Cohen's $d = -0.25$, $d = -0.10$, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | Not found |
| CBM-A (The Netherlands) [57] | RCT | N = 340 (14.41) | 1. Visual search (VS) training<br>2. VS placebo<br>3. Dot-probe attention (DP) training<br>4. DP placebo | *Primary outcomes:* Anxiety and depressive symptoms; *Secondary outcomes:* Self-esteem, test anxiety, social-emotional and behavioral problems, attentional control, stress reactivity | *Anxiety:* SCARED *Test anxiety:* PMT-K *Depression:* CDI | Baseline, post-test, 3 months, 6 months, 12 months | Small changes in anxiety, depression, and test anxiety scores were found for both VS training (effect sizes: Cohen's $d = 0.01$, $d = 0.24$, $d = -0.34$, respectively) and DP training ($d = -0.01$, $d = -0.01$, $d = 0.27$, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | Not found |
| EmoWM (The Netherlands) [58] | RCT | N = 168 (14.35) | 1. EmoWM<br>2. EmoWM placebo | *Primary outcomes:* Working memory, anxiety and depressive symptoms; *Secondary outcomes:* Stress reactivity, emotional functioning, test anxiety, self-esteem, stressful life events | *Anxiety:* SCARED *Test anxiety:* PMT-K *Depression:* CDI | Baseline, post-test, 3 months, 6 months, 12 months | Small changes in anxiety, depression, and test anxiety scores were found (effect sizes: Cohen's $d = 0.03$, $d = -0.12$, $d = -0.14$). No statistically significant differences between groups were found on any of emotional outcome measures. | Not found |

(*continued on next page*)

**Table 2**
Continued

| Intervention name (country) | Design | Sample (mean age/age range) | Conditions | Targeted area | Outcome measures | Measurement time points | Findings[a] | Availability |
|---|---|---|---|---|---|---|---|---|
| CBM-I (The Netherlands) [59] | RCT | N = 173 (14.35) | 1. CBM-I<br>2. CBM-I Placebo | *Primary outcomes:* Anxiety and depressive symptoms; *Secondary outcomes:* Interpretation bias, self-esteem, test anxiety, rumination, worry, stress reactivity | *Anxiety:* SCARED *Test anxiety:* PMT-K *Depression:* CDI | Baseline, post-test, 3 months, 6 months, 12 months | Small changes in anxiety, depression, and test anxiety scores were found (effect sizes: Cohen's $d$ = 0.19, $d$ = −0.24, $d$ = −0.28, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | Not found |
| CBM (The Netherlands) [60] | RCT | N = 240 (CBM: 14.12) | 1. Cognitive behavioral therapy (CBT)<br>2. CBM<br>3. Control | *Primary outcomes:* Social anxiety, test anxiety, threat-related automatic associations | *Social anxiety:* RCADS *Test anxiety:* Spielberger TAI | Baseline, post-test, 6 months, 12 months | Small changes in social anxiety and test anxiety were found in the control group over CBM (effect sizes: Cohen's $d$ = −0.15, $d$ = −0.22, respectively). Except for strong increase in positive automatic associations ($d$ = 0.61) from 6 to 12 months, no statistically significant differences were found between CBM and other groups. | Not found |
| PPI (Germany) [65] | RCT | N = 77 (15.78) with major depressive disorder | 1. PPI<br>2. Control group | *Primary outcomes:* Depressive symptoms, stress, negative and positive affect | *Depression:* BDI-II | Baseline, post-test, 2 weeks | Small changes in depression and stress scores were found (effect size: Cohen's $d$ = 0.22, $d$ = −0.20, respectively). No statistically significant differences between groups were reported. | Can be found on: https://www.ich-bin-alles.de |

ABM = attentional bias modification; BA-SSI = behavioral activation – single-session intervention; BDI = Short Beck Depression Inventory; BDI-II = Beck's Depression Inventory – Second Edition; CBM = cognitive bias modification; CBM-A = cognitive bias modification of attention; CBM-I = cognitive bias modification of interpretations; CDI = the Children's Depression Inventory; CDI-SF = Children's Depression Inventory 2 – short form; CESD-R = Center for Epidemiologic Studies Depression Scale Revised; DASS21 = the Depression, Anxiety and Stress Scale – 21 Items; EmoWM = emotional working memory training; GAD-7 = Generalized Anxiety Disorder Questionnaire; GM-SSI = Growth Mindset – Single-Session Intervention; MASC2 = the Multidimensional Anxiety Scale for Children-Second Edition; MFQ = Mood and Feelings Questionnaire; PHQ-8 = Patient Health Questionnaire – 8; PHQ-A = the Patient Health Questionnaire for Adolescents; PMT-K = "performance motivation test for children" (Original: Prestatie Motivate Test voor Kinderen); PPI = Positive Psychology Intervention; R-BDI = Revised Beck Depression Inventory; RCADS = the Revised Child Anxiety and Depression Scale ; RCADS-25 = the Revised Child Anxiety and Depression Scale – 25; SCARED = the Screen for Child Anxiety Related Emotional Disorders; SCAS = the Spence Children's Anxiety Scale; Spielberger TAI = the Spielberger Test Anxiety Inventory.

[a] Effect sizes were either converted to Cohen's d or Cohen's d was calculated from the provided post-treatment data.

website [52,54,63,70], 4 were available as mobile applications [53,62,64,66], and one was developed as computer software [61].

*Length and frequency of intervention (when and how much).* "Project Yes" [63] and "An Enhanced Psychological Mindset Session" [70] investigated a single-session intervention (SSI) with an approximate duration of 30 minutes. In contrast, the remaining interventions were offered over longer periods and recommended for more frequent use. Participants had access to the "CARE" app for 3 weeks, with a suggested usage of at least three times a day [64]. The intervention phase for both "Tita" app [62] and "Stressbusters" [61] lasted 8 weeks, with new content published weekly for the "Tita" users. The "WeClick" [53] app was available for 4 weeks, though it too was structured as an hour-long SSI. "Bite Back" [54] was offered for 6 weeks, with a recommended usage of at least an hour a week, and "Spark v2.1" [64] for 5 weeks, with new content being released once a week. While the duration was not explicitly stated for the "Grasping the Opportunity" [52] intervention, the presence of 10 modules and the scheduling of monthly reminders, along with the first post-test assessment occurring 4 months after commencement, suggest that participants could access the intervention for at least a month.

*Tailoring.* Among the examined interventions, only "CARE" [66] used a somewhat tailored approach to delivery, where participants had a 67% chance of receiving a mindfulness exercise, determined by their responses to a brief survey. None of the other analyzed interventions used this personalized approach to their delivery [52–54,61–64,70]. In addition, only "Grasping the Opportunity" [52] addressed how personalizing an intervention could potentially enhance participant engagement.

*Modifications to the intervention.* Two of the interventions were adapted from previously examined interventions. The "Enhanced Psychological Mindset Session" was based on the personality mindset intervention developed by Schleider and Weisz [72,73], enriched with additional content on self-compassion and the psychological acceptance model. Similarly, the "Grasping the Opportunity" intervention was derived from the CATCH-IT program, but it excluded the interpersonal psychotherapy component [74]. Despite these initial adaptations, there were no further modifications reported for any of the interventions during the evaluation phase [52–54,61–63,66,70], except for "Spark v2.1" [64]. "Spark v2.1" was modified halfway through the study to "Spark v2.2" by expanding version 2.1 with animations, a reward system, and additional content on problem-solving, mindfulness, and relapse prevention.

*Retention (how well).* Retention rates across all the studies could be considered moderate, with 3 exceptions. The "Stressbusters," "Grasping the Opportunity,", and "Spark v2.1" studies achieved a notably high retention rate of 93%, 97%, and 96%, respectively, through to the final follow-up [52,61,64]. Meanwhile, 3 studies reported retention rates of around 70% [54,63,66], while the remaining interventions recorded rates of below 60% [53,62,70], with "An Enhanced Psychological Mindset Session" having the lowest rates of approximately 52% [70].

*Acceptability and engagement*

Diverse outcomes characterized the analyzed studies, reflecting a wide range of participant engagement and satisfaction levels. In the "Grasping the Opportunity" [52] intervention, only 10% of participants completed all the modules, with a median time of 39.3 minutes spent on the website. In contrast, 68.1% of individuals finished all the stories provided in the "WeClick"' [53] intervention, with an average app usage time of 19 minutes. Furthermore, 90% of "WeClick" users described the app as enjoyable, and 65.9% found it helpful. Overall, 83.8% of "Project YES" participants finished the session in full [63], and 86% of "Stressbusters" users completed all 8 sessions [61]. The CARE app was accessed an average of 47.42 times, with its ease of use rated highly at a mean score of 6.11 of 7 [66]. Moreover, 79% of participants in the Bite Back intervention indicated that the website was fun to use, 84% found the content interesting, and 90% considered it easy to use [54]. However, 58% reported time constraints as a barrier to frequent access, and only 23% adhered to the recommended usage time. Participants in the "Spark v2.1" study rated the app as moderately enjoyable, easy to use, and effective in reducing depressive symptoms, with only 40% completing the last (fifth) module [64]. Finally, all participants in "An Enhanced Psychological Mindset Session" completed SSI within 20–30 minutes, finding the content easy to understand with a mean score of 7.86 of 10 [70]. Recommendations to others were somewhat lower, at 6.79 of 10, but the level of enjoyment was high, with an average score of 7.98 of 10. Overall, 72.5% of "Tita" users reported practicing at least once a week with 70.6% of individuals practicing up to 10 minutes a day [62]. This highlights the varied experiences of participants and the significant impact of intervention design on user engagement and satisfaction.

## Discussion

We identified 20 studies that focused on decreasing anxiety and depressive symptoms in adolescents through digital interventions delivered without additional support. Many of the interventions that were classified as promising incorporated CBT frameworks, multimedia content, and self-paced delivery.

The current systematic review aimed to evaluate the "promise" of digital interventions for anxiety and depression in adolescents and their characteristics. It incorporated the RE-AIM framework dimensions with significant emphasis on interventions' effectiveness and the risk of bias. This review identified 20 studies, three of which were deemed "Quite Promising" [52,61,63], six "Slightly Promising" [53,54,62,64,66,70], 4 "Inconclusive Promise," [67–69,71] and seven "Not Promising" [55–60,65]. Interventions with significant results and/or medium to large effect sizes, low risk of bias, and somewhat meeting the RE-AIM dimensions were classified as "Quite Promising." Conversely, RCTs with small effect sizes and/or insignificant results were considered "Not Promising." Interventions not meeting the criteria for those 2 categories were considered "Slightly Promising." Pilot and feasibility trials that otherwise met the criteria for the "Not Promising" category were classified as "Inconclusive Promise," acknowledging their exploratory nature and potential for improvement and validation in future research. The primary barrier to being characterized as "Quite Promising" was the risk of bias, where all slightly promising interventions raised some concerns, often due to a lack of analysis plan in the study protocol. None of the promising interventions fully met the RE-AIM framework dimensions.

While our review shares similarities with the systematic review conducted by Wright et al., which examined the

**Table 3**
Assessment of interventions' promise

| Intervention name | Risk of bias | Effectiveness | RE-AIM judgment |
|---|---|---|---|
| Quite Promising | | | |
| Grasp the Opportunity [52] | Low risk | The intervention demonstrated a significant reduction in depressive symptoms at the 12-month follow-up (effect size: Cohen's $d = -0.36$, $p = .04$). Further improvements in depression, anxiety, and stress were observed at the 8-month follow-up (effect sizes: $d = -0.28$, $d = -0.35$, $d = -0.27$, respectively). While the retention rate at follow-up was high (97%), only 10% of participants completed all the modules, indicating a challenge in maintaining participant engagement over time. | Somewhat met the RE-AIM dimensions. |
| Project YES [63] | Low risk | Statistically significant decrease was found in depressive symptoms, hopelessness, and restrictive eating for both BA-SSI (effect sizes: Cohen's $d = 0.18$, $d = 0.17$, $d = 0.15$, respectively) and GM-SSI ($d = 0.18$, $d = 0.15$, $d = 0.10$, respectively) at 3-month follow-up. Significant increase in agency for BA-SSI at postintervention ($d = -0.31$) and for GM-SSI ($d = -0.12$) at 3-month follow-up. In addition, statistically significant improvements in anxiety symptoms were reported for GM-SSI ($d = 0.10$) at 3-month follow-up. No statistically significant changes were found in anxiety symptoms for BA-SSI ($d = 0.02$). The study achieved a retention rate of 66.6%. | Somewhat met the RE-AIM dimensions. |
| Stressbusters [61] | Low risk | Statistically significant improvements were observed for both anxiety and depressive symptoms at postintervention (effect sizes: Cohen's $d = 0.82$, $d = 0.41$, respectively). The study achieved a retention rate of 92.9%. | Somewhat met the RE-AIM dimensions. |
| Slightly Promising | | | |
| CARE [66] | Fair quality[a] | Significant reductions in rumination and anxiety were found, with these improvements maintained over the 12-week follow-up (effect sizes: Cohen's $d = 0.35$, $d = 0.42$, respectively). No statistically significant changes were found for worry and depressive symptoms ($d = 0.27$, $d = 0.16$, respectively). A retention rate of 71.2% indicated moderate participant engagement. However, this should be interpreted with caution due to the lack of a control group. | Somewhat met the RE-AIM dimensions. |
| WeClick [53] | Low risk | Significant improvements were observed in the intervention group at 4-week post-test in well-being and intentions to seek help (effect sizes: Cohen's $d = 0.37$ and $d = 0.36$, respectively). Unlike well-being, help-seeking intentions sustained at 12-week follow-up. No differences between groups were found for anxiety and depression. The study achieved a retention rate of 59.6%. | Somewhat met the RE-AIM dimensions. |
| Bite Back [54] | Some concerns | Participants in the intervention condition showed a considerable reduction in DASS-21 depression scores (effect size: Cohen's $d = -0.45$) and stress scores ($d = -0.43$) at the 6-week postintervention mark. No statistically significant changes were reported for anxiety ($d = -0.06$) at the follow-up. In addition, they exhibited significantly higher scores on the SWEMWBS ($d = 0.39$), indicating enhanced well-being. The retention rate in the study was moderate, with 71% of the total sample and 58% of the intervention condition participants completing the program. | Somewhat met the RE-AIM dimensions. |
| An Enhanced Psychological Mindset Session [70] | Some concerns | Significant reductions were found in the total RCADS-25 score as well as anxiety and depression subscales in the intervention group, which persisted throughout the 8-week follow-up (effect sizes: Cohen's $d = -0.35$, $d = -0.58$, $d = -0.23$, respectively). A 52.5% retention rate indicated moderate participant involvement. | Somewhat met the RE-AIM dimensions. |
| Tita [62] | Some concerns | Significant reductions were found in anxiety, depression, and sleep problems (effect sizes: Cohen's $d = 0.26$, $d = 0.15$, $d = 0.11$, respectively), increase in psychological quality of life, mindfulness, self-compassion, and happiness (effect sizes: Cohen's $d = 0.16$, $d = 0.15$, $d = 0.14$, $d = 0.22$, respectively). The study achieved a retention rate of 58.5%. | Somewhat met the RE-AIM dimensions. |
| Spark v2.1 [64] | Some concerns | Statistically significant reductions were found in individuals with mild-to-severe symptoms of depression (effect size: Cohen's $d = -0.16$). Small changes in anxiety symptoms were found, however, no statistical significance was provided ($d = -0.35$). | Somewhat met the RE-AIM dimensions. |
| Potentially Promising | | | |
| Breathe [67] | Low risk | Small changes in anxiety scores were found (effect size: Cohen's $d = 0.07$). No statistically significant differences between groups were reported. | - |
| Spark v2.0 [71] | Some concerns | Small changes in depression and anxiety scores were found (effect size: Cohen's $d = 0.20$, $d = -0.18$, respectively). No statistically significant differences between groups were reported. | - |
| Stressbusters (12-month follow-up) [68] | Some concerns | Small changes in anxiety and depression scores were found (effect sizes: Cohen's $d = 0.21$, $d = 0.05$, respectively). No statistically significant differences between groups were reported. | - |
| Stressbusters (4-month follow-up) [69] | Some concerns | Mean scores for depression and mood decreased and quality of life increased at 4-month follow-up. However, there was no statistical significance provided. Small changes in anxiety and depression scores were found (effect sizes: Cohen's $d = 0.30$, $d = 0.00$, respectively). | - |
| Not Promising | | | |
| CBM-I [55] | Low risk | Small changes in anxiety and depression scores were found for both scenario (effect sizes: Cohen's $d = 0.02$, $d = 0.22$, respectively) and picture-word conditions (effect sizes: Cohen's $d = 0.21$, $d = 0.16$, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | - |
| ABM [56] | Low risk | Small changes in anxiety and depression were found in the control group over VS training (effect sizes: Cohen's $d = -0.25$, $d = -0.10$, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | - |

**Table 3**
Continued

| Intervention name | Risk of bias | Effectiveness | RE-AIM judgment |
|---|---|---|---|
| CBM-A [57] | Some concerns | Small changes in anxiety, depression, and test anxiety scores were found for both VS training (effect sizes: Cohen's $d = 0.01$, $d = 0.24$, $d = -0.34$, respectively) and DP training (effect sizes: Cohen's $d = -0.01$, $d = -0.01$, $d = 0.27$, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | - |
| EmoWM [58] | Some concerns | Small changes in anxiety, depression, and test anxiety scores were found (effect sizes: Cohen's $d = 0.03$, $d = -0.12$, $d = -0.14$). No statistically significant differences between groups were found on any of emotional outcome measures. | - |
| CBM-I [59] | Some concerns | Small changes in anxiety, depression, and test anxiety scores were found (effect sizes: Cohen's $d = 0.19$, $d = -0.24$, $d = -0.28$, respectively). No statistically significant differences between groups were reported on any of emotional outcome measures. | - |
| CBM [60] | Low risk | Small changes in social anxiety and test anxiety were found in the control group over CBM (effect sizes: Cohen's $d = -0.15$, $d = -0.22$, respectively). Except for strong increase in positive automatic associations (effect size: Cohen's $d = 0.61$) from 6 to 12 months, no statistically significant differences were found between CBM and other groups. | - |
| PPI [65] | Some concerns | Small changes in depression and stress scores were found (effect size: Cohen's $d = 0.22$, $d = -0.20$, respectively). No statistically significant differences between groups were reported. | - |

ABM = attentional bias modification; BA-SSI = behavioral activation – single-session intervention; CBM = cognitive bias modification; CBM-A = cognitive bias modification of attention; CBM-I = cognitive bias modification of interpretations; DP training = dot-probe attention training; EmoWM = emotional working memory training; GM-SSI = Growth Mindset – Single-Session Intervention; PPI = positive psychology intervention; RoB 2 = a revised tool for assessing risk of bias in randomized trials (Sterne et al., 2019); VS training = visual search attention training.

[a] Study Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group (NHLBI, NIH).

characteristics of interventions aimed at mental health promotion among adolescents [41], our review focuses specifically on interventions targeting the reduction of anxiety and depressive symptoms. In addition, we have introduced a categorization of "promise" based on effectiveness and real-world applicability, thereby providing a detailed and nuanced understanding of the range and impact of digital interventions in these specific mental health areas.

Identified interventions demonstrated variability in successfully addressing adolescents' needs. For instance, the CARE app tailored the content to individual questionnaire scores, reflecting an understanding of the need for a personalized approach, although participants' views of this approach were not explored in this original study [66]. Some older adolescents (primarily those above 16 years old) reported that the Bite Back Web site, which offered generic content, was not sufficiently engaging, suggesting that the content might have been better suited for younger adolescents [54]. With the exception of the Enhanced Psychological Mindset Session [70], all interventions were self-paced, which is consistent with adolescents' preference for independence [75]. However, in "Stressbusters" [61], classroom spaces were provided to maintain research quality and explore the potential for the intervention to be adapted for stepped care delivery in the future. Time constraints were commonly reported as a significant barrier to engagement [76]. These findings suggest a need for further investigation to identify the optimal intervention duration that aligns with adolescents' lives.

Promising interventions shared some common features that possibly contributed to their effectiveness. The majority followed a CBT-based approach, which is well-established for addressing mental health challenges by targeting negative thought patterns and behaviors [77]. However, some promising interventions adopted different evidence-based approaches such as positive psychology, mindfulness, or growth mindset theory. All promising interventions included interactive and multimedia content, such as videos, audio, animations, or storytelling, which are known to enhance engagement in adolescent participants [30].

This review has identified several limitations of current research on digital mental health interventions. There was a noticeable lack of demographic data reported across studies. Most only reported participants' age and gender, making it difficult to establish whether those from disadvantaged groups that are at greater risk of developing mental health disorders were adequately represented [78,79]. Several studies demonstrated some risk of bias often due to the absence of a detailed analysis plan in the protocol. This issue led to classifications of some of these studies as "Slightly Promising" instead of "Quite Promising," indicating a pressing need for implementation of more rigorous research standards. In addition, the RE-AIM framework, although a useful tool for assessing interventions' reach and real-life applicability, could not be fully applied to any study due to a lack of detailed reporting. This shortfall highlights significant gaps in research design and reporting. Challenges such as obtaining parental consent significantly affected participant recruitment and the overall reach of interventions. Both Cavazos-Rehg et al. [80] and Samargia et al. [81] have previously identified parental consent as a significant barrier to accessing mental health services for adolescents. These findings underline the necessity for more inclusive, detailed, and standardized methodologies in future research.

Although the limitations of the included studies have been discussed, certain limitations of the review itself must also be acknowledged. The reference lists of included studies were not examined, which may have led to the exclusion of potentially relevant studies. All the included studies relied on self-reported symptoms, which are susceptible to response bias resulting from participants' potential over- or under-reporting of those symptoms. Another significant limitation of this review is its reliance on narrative methods to assess the RE-AIM framework dimensions. To the best of our knowledge, there is no accessible tool that comprehensively evaluates an intervention's impact and sustainability in practice, covering all aspects as thoroughly as the RE-AIM framework. This highlights a clear research need for the development of a rigorous tool that can provide a detailed

**Table 4**
TIDieR Checklist characteristics, acceptability, and engagement of promising interventions

| Name | Rationale/theory (why) | Materials and procedures (what) | Intervention provider (who) | Mode of delivery (how and where) | Length and frequency of intervention (when and how much) | Tailoring | Modifications to the intervention | Retention (how well) | Acceptability and engagement |
|---|---|---|---|---|---|---|---|---|---|
| Quite Promising | | | | | | | | | |
| Grasping the Opportunity [52] | CBT and BA | Videos, interactive elements, and stories of young people | Technical support was provided by the research team if necessary. Monthly reminders through email and WhatsApp. | Web-based, self-paced, recommended to complete during school hours | 10 modules | Generic | Modified from CATCH- IT before implementation [68]. No changes were made throughout the duration of the study. | The retention rate: 97% | 10% of participants completed all the intervention modules. The median time spent on the website was 39.3 minutes. |
| Project YES [63] | BA and growth mindset of personality | Stories of young people, along with lessons on brain and neuroplasticity, available in text and audio formats as well as psychoeducational videos | No support. | Web-based, self-paced | SSI 20–30 minutes | Generic | No modifications were made throughout the duration of the study. | The retention rate: 66.6% | 83.8% of participants finished the session in full. Participants rated the website as enjoyable with a score of around 3.9 out of 5. They also indicated that they would recommend it to a friend, giving it an average score of around 4/5. |
| Stressbusters [61] | CBT | Interactive multimedia presentations with videos, animations, and graphics | No support. | Computer-based, self-paced, completed in classroom during school hours | 8 sessions, available for 8 weeks | Generic | No modifications were made throughout the duration of the study. | The retention rate: 92.9% | 93% completed at least four sessions, with 86% finishing all sessions. |
| Slightly Promising | | | | | | | | | |
| CARE [66] | Mindfulness | Guided audio mindfulness exercises | No support. Daily and weekly reminders. | Mobile application, self-paced | 3 weeks, at least 3 times per day | Tailored | No modifications were made throughout the duration of the study. | The retention rate: 71.2% | The app was accessed 47.42 times on average. Participants rated the intervention as easy to use with a mean score of 6.11 out of 7. |
| WeClick [53] | CBT and SLT | Interactive storytelling, skill-developing activities, character profile building | No support. Build-in weekly reminders. | Mobile application, self-paced | SSI, 1 hour, available for 4 weeks | Generic | No modifications were made throughout the duration of the study. | The retention rate: 59.6% | 68.1% of participants finished all the stories provided. The average time spent on the app was 19 minutes. 90% of individuals said the app was enjoyable, and 65.9% reported it being helpful or extremely helpful. |
| Bite Back [54] | Positive psychology | Videos, psychoeducational information, interactive exercises, community noticeboard | No support. Weekly reminders through email. | Web-based, self-paced | 6 weeks, at least an hour a week | Generic | No modifications were made throughout the duration of the study. | The retention rate: 71% | 79% of individuals said the Web site was fun, 84% found it interesting, and 90% indicated that it was easy to use. 58% of participants reported not using the Web site frequently due to time constraints. Only 23% used the intervention for the recommended amount of time. |
| An Enhanced Psychological Mindset Session [70] | Growth mindset theory | Psychoeducational animations, videos of young people's stories, written task | Research team present during study to ensure protocol was followed, no support was provided. | Web-based, self-administered, completed in classroom during school hours | SSI, 30 minutes | Generic | Modified from psychological mindset intervention (Project YES) before implementation [66,67]. No changes were made throughout the duration of the study. | The retention rate: 52.5% | All participants completed the entire intervention within 20–30 minutes. A mean score of 7.86 of 10 indicated that the intervention was easy to understand. A score of 6.79 of 10 suggested that some individuals would recommend the intervention to others. An average score of 7.98 of 10 signifies enjoyment from participating in the study. |

**Table 4**
Continued

| Name | Rationale/theory (why) | Materials and procedures (what) | Intervention provider (who) | Mode of delivery (how and where) | Length and frequency of intervention (when and how much) | Tailoring | Modifications to the intervention | Retention (how well) | Acceptability and engagement |
|---|---|---|---|---|---|---|---|---|---|
| Tita [62] | Mindfulness | Downloadable-guided meditations, video lectures on mindfulness, compassion, stress management, and well-being | No support. Daily and weekly reminders. | Mobile application, self-paced | 8 weeks, a video released once a week | Generic | No modifications were made throughout the duration of the study. | The retention rate: 58.5% | 72.5% of participants practiced at least once a week, and 39.0% reported practicing daily or almost daily. 70.6% of individuals practiced up to 10 minutes and 12.8% for 10–20 minutes a day. |
| Spark v2.1 [64] | CBT and BA | Interactive activities, therapeutic guide/main character, psychoeducational content, reward system, and animations | No support. Reminders were sent if the app was not opened for 3 days. | Mobile application, self-paced | 5 weeks, content released once a week | Generic | Yes, the intervention was modified halfway through the study. Spark v2.2 expanded on the version 2.1 with additional content on problem-solving, mindfulness, and relapse prevention. Additional reward system and animations were added. | The retention rate: 95.63% | 40% of participants in the Spark group completed module 5. Participants assessed the app as moderately enjoyable, successful in improving depressive symptoms, and easy to use. |

BA = behavioral activation; CBT = cognitive behavioral therapy; SLT = social learning theory; SSI = single-session intervention.

and standardized evaluation. While the review was specifically focused on the general population or individuals with heightened anxiety and/or depressive symptoms to complement the Sleep Well Study, it did not cover interventions aimed at other mental health issues that so often co-occur with anxiety and/or depression [82–84]. The strengths of this review lie primarily in its comprehensive analysis and systematic classification of existing digital mental health interventions as well as its novel emphasis on real-world applicability. Given the rapid increase in digital mental health interventions, it is essential to evaluate their potential for real-world impact, as many are developed but seldom transitioned into practical application beyond research contexts.

Several recommendations for future digital mental health interventions have been identified to address the problems found through this review. First, using methods to enhance adolescents' engagement could be beneficial [85,86]. This could be strengthened by directly involving adolescents in intervention development processes through co-design approaches to ensure its relevance and appeal to this age group [87–89]. In addition, ensuring the inclusion of diverse populations in research, particularly those representing different ethnicities, gender identities, and socioeconomic backgrounds, can significantly improve the generalizability of the findings and their reach [90].

Future systematic reviews could expand to include interventions with varied levels of support provided throughout the implementation phase and those that have been delivered in different settings (e.g., school, clinic). By broadening the scope, future reviews can enrich the understanding of diverse intervention characteristics across different contexts and levels of support, thereby enhancing knowledge for future intervention development. Furthermore, the systematic application of the RE-AIM framework could further facilitate the evaluation of digital interventions' real-world applicability.

## Conclusion

This systematic review focused on a novel use of the RE-AIM framework for the evaluation of digital interventions for adolescent anxiety and depression. The analysis found that only a subset of interventions was deemed "Quite Promising," which highlights the challenges and variability in their effectiveness, risk of bias, and real-world impact. This review underscores the need for more standardized methodologies and comprehensive reporting of research on digital mental health interventions. Future research should aim to enhance accessibility and practical applications of these interventions to ensure they can benefit a broader demographic of adolescents. The insights from this review could not only offer a foundation for discussion on evaluating and reporting the real-world impact of these interventions but also serve as a resource to inform future development and investigation of digital mental health interventions.

## Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work PK used ChatGPT to verify text's grammatical accuracy (spelling and grammar). After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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## Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jadohealth.2025.05.021.

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