Effectiveness of Digital Behavioral Activation Interventions for Depression and Anxiety: A Systematic Review and Meta-analysis

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Abstract

Background: As digital interventions gain prominence in mental health care, they present opportunities to improve access and scalability. Despite their potential, the overall impact of digital Behavioral Activation (BA) interventions across different formats and populations is not yet fully understood. Further research is necessary to evaluate their effectiveness across settings and optimize their application.

Objective: This systematic review and meta-analysis aimed to assess the characteristics and functions of digital BA interventions, evaluate their effects on patient outcomes, identify limitations, and highlight gaps in the existing research to guide future directions.

Methods: A comprehensive search of databases (PubMed, Embase, Web of Science, APA PsycInfo, and ClinicalTrials.gov) identified randomized controlled trials (RCTs) assessing the effectiveness of digital BA interventions for depression and anxiety. Two independent reviewers screened studies, extracted data, and assessed risk of bias using the Cochrane Risk of Bias Tool. Meta-analyses, using a random-effects model, were performed on outcomes such as depression, anxiety, quality of life (QoL), BA scores, functioning, disability, and stress. Statistical heterogeneity was evaluated with the I^2 statistic. Six studies that did not meet meta-analysis criteria underwent narrative synthesis.

Results: Eighteen studies were included, covering three intervention types: (1) internet-based BA (iBA), which delivers online therapies to foster new behavioral activities for depression management; (2) electronic messaging-based BA, involving prompts to support behavior change; and (3) telehealth-based BA, providing remote healthcare services. Of these, twelve studies were included in the meta-analysis. Digital BA interventions significantly reduced depressive symptoms at 2 months ($p < 0.00001$, $I^2 = 0\%$), 3 months ($p = 0.001$, $I^2 = 51\%$), and 6 months ($p = 0.009$, $I^2 = 29\%$) post-treatment, but not at 12 months ($p = 0.82$, $I^2 = 89\%$). BA scores showed significant improvement at 6 months ($p < 0.00001$, $I^2 = 0\%$). QoL also improved significantly at 3 months ($p = 0.002$, $I^2 = 22\%$) and 6 months ($p = 0.009$, $I^2 = 0\%$), while stress levels were significantly reduced at 3 months ($p = 0.0005$, $I^2 = 25\%$). Anxiety and functioning/disability outcomes did not show significant changes at 3 or 6 months.

Conclusions: Digital BA interventions offer meaningful short-to-medium-term benefits for alleviating depressive symptoms and improving QoL, though their impact diminishes by 12 months. Variations in intervention types, guidance levels, and treatment durations underscore the need for future studies to refine these interventions for specific populations. Further research should address the long-term effectiveness and disentangle the role of BA in multi-component approaches.

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INTRODUCTION

Depression and anxiety persist as prevalent and debilitating mental health threats worldwide,[1–3] significantly impacting an individual's quality of life,[4,5] functioning,[6,7] and overall health outcomes.[8,9] The impacts of major depressive disorder Gvary across age groups, with adolescents more likely to experience significant vegetative symptoms, including changes in appetite and loss of energy, whereas adults are more likely to experience anhedonia or difficulty concentrating.[10] Similarly, adults with generalized anxiety disorder tend to experience higher levels of distress/interference and lower levels of fatigue compared to younger age groups despite equivalent severity levels.[11]

Various psychotherapeutic treatments help alleviate symptoms of depression and anxiety, including psychosocial education, mindfulness and cognitive behavioral therapy.[12] Among these, cognitive behavioral therapy (CBT) is a widely used and effective behavioral treatment shown to reduce depression symptoms and anxiety.[13–15] CBT is a structured, goal-oriented talk therapy that helps individuals recognize how their beliefs may influence their actions, unlearn negative thoughts, and replace them with healthier thinking patterns and habits. Behavioral activation (BA), a form of CBT, aims to improve individuals' mood and functioning by encouraging them to engage in activities that align with their personal values.[16] BA has found to be effective in reducing depression and anxiety severity across various settings and populations.[17,18]

Over the past decade, BA has been adapted into digital formats that offer accessible and scalable treatment options due to the growing utilization of and advancements in digital health technologies.[19] Moreover, digital BA treatments delivered via web-based platforms and mobile applications addressed other social and structural barriers to accessing mental health services, such as mental health stigma,[20] insufficient mental health resources, and costs often associated with traditional in-person therapy.[21]

A systematic review of nine randomized controlled trials (RCT) highlighted the efficacy of internet-based BA (iBA) interventions involving smartphone apps or websites for treating depression and anxiety symptoms and improving quality of life.[22] Of these nine interventions, six solely utilized BA and three combined BA with other therapy components like problem-solving therapy or acceptance and commitment therapy. The review concluded that iBA interventions showed promise to be as effective as traditional face-to-face methods at reducing various forms of depression including subthreshold depression, postpartum depression, and depression with comorbid chronic conditions like diabetes. A similar updated review[23] assessing the cumulative efficacy of iBA interventions in treating depression symptoms and anxiety concluded that iBA interventions were more effective at reducing depression symptoms and anxiety severity than control groups immediately post-intervention, which primarily included treatment as usual (TAU) in addition to active controls that included digital psycho-educational materials and telephone support calls. However, the review also reported no significant improvement in depressive symptoms or anxiety at 6-months follow-up. Despite the invaluable insights on the nature and impact of iBA interventions on depression and anxiety, the scope of these reviews remains limited to only this single type of digital BA intervention. In other words, we lack a comprehensive understanding of the different types of digital BA interventions and their overall impacts in treating mental health conditions. To address this gap, we conducted a systematic review and meta-analysis to synthesize and appraise the empirical evidence on the effectiveness of various types of digital BA interventions for reducing depression symptoms and/or anxiety.

Our review objectives were three-fold: *first*, to characterize the nature and functions of digital BA interventions; *second*, to ascertain the impact of digital BA interventions on patient outcomes; and *lastly*, to highlight gaps in research and future directions for digital BA intervention research and its use in practice.

METHOD

Search strategy

The published literature was searched using strategies created by a medical librarian (MD) for RCTs on digital BA interventions for depression and anxiety and established using a combination of standardized terms and keywords. The search was run on November 15, 2023, in multiple databases: Embase.com 1947-, Ovid Medline 1946-, Web of Science 1900-, PubMed 1946-, Clinicaltrials.gov, and APA PsycInfo 1800-. The search was restricted using an English-language filter and the Cochrane-approved RCT filter was used in Embase, Ovid Medline, and Web of Science. The search in APA PsyInfo was restricted using its methodology filter for clinical trials. Full search strategies are provided in *Appendix S1*.

Study screening and selection

Titles and abstracts of the retrieved articles were screened for eligibility by one reviewer (JM). Eligible studies included RCTs of digital mental health interventions utilizing BA in adults over the age of 18 and who screened positive for symptoms of anxiety and/or depression. Digital mental health interventions were defined as evidence-based digital interventions to prevent, manage, or treat mental disorders or diseases,[24] and included smartphone and tablet applications, internet-based programs, virtual reality, media-based programs, video games, computer programs, chatbots, telehealth, social media, podcasts, and webinars. Only English and original research articles published in peer-reviewed journals were included (see *Appendix S2* for inclusion criteria). The following types of articles were excluded: feasibility studies, study protocols, studies in pediatric patients, retrospective studies, design studies, evaluation studies of non-digital BA interventions, conference abstracts, and qualitative studies (see *Appendix S3* for excluded studies).
Titles and abstracts that met the inclusion criteria and seemed relevant were retrieved for a full-text review. Two reviewers (JM, EJ) independently assessed full-text articles for inclusion and disagreements were discussed and resolved with a third reviewer (JA). References from included articles were also screened for eligibility.

Data extraction and management

A data abstraction form for extracting the relevant data from the included studies was iteratively developed and pilot-tested (see *Appendix S4* for data extraction template). The final extraction was duplicated by two reviewers (JM, EJ), who independently extracted data pertaining to the population, intervention, comparison group, and outcomes (PICO) characteristics. Data discrepancies were reviewed and adjudicated by a third reviewer (JA).

Data analysis and synthesis

Two reviewers (JM, EJ) coded the extracted data from the included studies. For example, to fully characterize the nuances underlying the interventions, the reviewers coded the technology type, intervention design approaches, theories driving the intervention, etc. (see *Appendix S5* for definitions of terms used in the review). All outcomes reported in the included studies were retrieved and organized as a matrix to avoid reporting bias. Studies reporting similar outcomes were pooled for meta-analysis and narrative synthesis.

Meta-analysis

We conducted meta-analysis across studies to ascertain the effects of digital BA interventions on the selected outcomes. Studies that reported similar outcomes (with ≥ 2 studies) were included for meta-analysis. Studies were excluded from a meta-analysis if they had insufficient data needed for a

pooled analysis. However, where possible, missing aggregate data such as the aggregate standard deviation (SD) for two separate trials within the same study were estimated through weighted averages using the provided means and standard deviations from each subgroup. A random-effects model was used, statistical heterogeneity was assessed using the I^2 test statistic, and the level of significance was set at $p \leq 0.05$. All analyses were conducted using Review Manager 5.

Narrative synthesis

Narrative synthesis was conducted for studies with insufficient reporting of outcome data and/or for outcomes with a small number of studies (<2 studies per outcome) and for studies that compared more than one intervention to the control; these studies had outcomes that could not be pooled for the meta-analysis or vote counting.

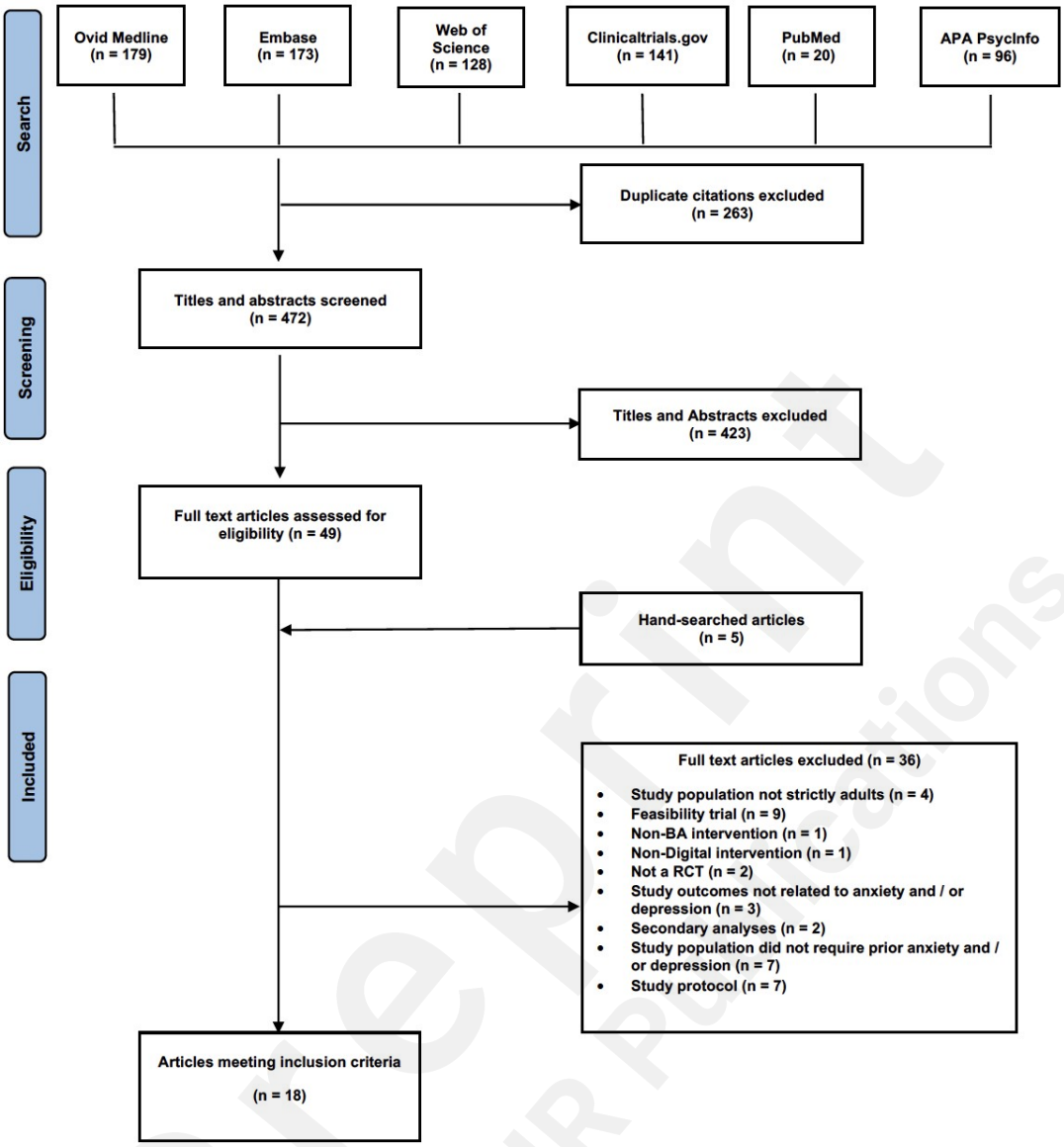
Risk of bias assessment

The Cochrane Risk of Bias (RoB) 1.0 Tool[25] was used to assess the quality of RCTs by assessing each study as having high, low, or unclear bias across seven different domains: random sequence generation, allocation concealment, blinding of personnel and participants, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other bias. RoB were independently assessed by two reviewers (JM, EJ) and adjudicated by a third reviewer (JA). Approximately 10% of the data required further review due to disagreements resolved through team discussion until 100% consensus was reached.

RESULTS

Our search yielded a total of 735 articles. After removing 263 duplicates, 472 articles were selected for initial screening. After title and abstract screening, 49 full-text articles were retrieved for full-text review. Five additional articles were identified through manual screening. Based on our full-text review, 18 articles met the eligibility criteria with two articles reporting on the same study,[26,27] resulting in a total of 18 included articles (Figure 1).

Figure 1. Study selection process (PRISMA[28])



Characteristics of included studies

Eight studies were conducted in the Americas,[26,27,29–34] and the remaining ten studies in Europe. Seven studies recruited participants from healthcare settings,[31,34 26,27,32,33,35] and the rest from the general public, through methods such as advertisements,[30,36–40] health insurance companies,[41,42] and regional associations of school psychologists.[43] Table 1 presents the characteristics of the included studies.

Table 1. Included study characteristics.

Study ID	Country	Study Arms	Sample Size	Population	Recruitment Setting	Intervention Type	Control Type
Araya (2021)[34]	Brazil; Peru	2	Int: 657 Con: 655	Adults receiving treatment for hypertension / diabetes with a PHQ-9 score higher than 10	Healthcare	iBA	EUC
Birney (2016)[30]	US	2	Int: 150 Con:	Employed adults with mild-to-moderate depressive symptoms	General public	iBA	Additional resources about

			150	(PHQ-9)			depression
Buntrock (2015)[41]	Germany	2	Int: 202 Con: 204	Adults suffering from subthreshold depression (CES-D)	General public	iBA	Non-BA digital intervention
Carlbring (2013)[36]	Sweden	2	Int: 40 Con: 40	Adults with a MADRS-S between 15-30y	General public	iBA	WLC
Choi (2020),[26] Marti (2021)[27]	US	3	BA: 99 PST: 98 Con: 98	Homebound adults > 50y with moderate to severe depressive symptoms (HAMD) in Central Texas	Healthcare	Telehealth	PST digital intervention, or Telephone support calls
Dahne (2023)[29]	US	2	Int: 103 Con: 47	Adults who smoke ≥ 5 cigarettes per day and with symptoms of elevated depression (PHQ-8)	General public	iBA	TAU
Danaher (2023)[31]	US	2	Int: 96 Con: 95	Perinatal adult women with depression recruited from NorthShore University HealthSystem	Healthcare	iBA	TAU
Ebert (2014)[43]	Germany	2	Int: 75 Con: 75	Working teachers with depressive symptoms (CES-D)	General public	iBA	WLC
Guertler (2023)[35]	Germany	2	Int: 227 Con: 229	Adults who experienced subthreshold depression (DSM-IV)	Healthcare	Electronic messages	TAU
Jelinek (2020)[37]	Germany	3	Int: 37 Con: 32 TAU: 35	Adults between 18-65y with depressive symptoms	General public	iBA	TAU or active control
Ly (2013)[39]	Sweden	2	Int: 40 Con: 41	Adults with a score of at least 5 on PHQ-9	General public	iBA	Non-BA digital intervention
Ly (2015)[38]	Sweden	2	Int: 46 Con: 47	Adults with depressive symptoms	General public	Hybrid (iBA + face to face sessions)	Non-digital BA Intervention
Muelle	German	2	Int:	Adults between 18-65y	General	iBA	TAU

r-Weinitschke (2023) [40]	y		64 Con: 64	with depressive symptoms (PHQ-9 and QIDS-C)	public		
Naik (2019) [32]	US	2	Int: 136 Con: 89	Veterans with uncontrolled diabetes and depressive symptoms in Southeast Texas	Healthcare	Telehealth	EUC
Nobis (2015) [42]	Germany	2	Int: 129 Con: 127	Adults with diabetes and comorbid depressive symptoms (CESD)	General public	iBA	Non-BA digital intervention
Sanabria-Mazo (2023) [44]	Spain	3	BA: 78 ACT: 78 Con: 78	Adults between 18-70y with a diagnosis of chronic lower back pain and displaying moderate to severe depressive symptoms (PHQ-9)	Healthcare	Telehealth	ACT digital intervention, or TAU
Scazufca (2023) [33]	Brazil	2	Int: 298 Con: 305	Adults > 60y with depressive symptoms (PQH-9)	Healthcare	Electronic messages	EUC

Abbreviations: ACT=Acceptance and Commitment Therapy, BA = Behavioral Activation, CBT = Cognitive Behavioral Therapy, HAPA = Health Action Process Approach, PST = Problem-Solving Therapy, WLC = Wait List Control, TAU = Treatment As Usual, EUC = Enhanced Usual Care

Population

All studies, by design, targeted populations with depression. Three studies had an inclusion criteria of age greater than 50,[26,27,33] while three other studies had an age cap. Two of these studies limited participation to adults 18-65 years of age,[37,40] while the third study was limited to 18-70 years.[44]
The remaining studies included all patients older than 18 years of age (n=12). However, these studies had varying participant inclusion criteria: three studies enrolled patients directly from healthcare settings;[33–35] five enrolled patients with access to internet;[30,31,37,41,43] three involved patients living in Sweden;[36,38,39] three enrolled patients who could understand Spanish;[26,27,44] one enrolled patients who were heavy smokers;.[29] two involved patients with German health insurance;[40,42] and one focused only on veteran populations in Texas.[32]

Interventions

Three major types of digital BA interventions were identified across studies: (1) internet-based BA interventions (iBA) that deliver web-based therapies through self-guided or minimally guided online platforms that help patients with depression develop new behavioral activities; (2) electronic messaging-based BA interventions that use messaging technologies to deliver periodic prompts and support via SMS, email, or app notifications to encourage behavior change; and (3) telehealth-based BA interventions that offer real-time clinician-led therapy through remote communication tools like video conferencing or telephone calls, aiming to provide BA services remotely. 67% of interventions used iBA, encompassing interactive websites or smartphone apps (n=12), [29–31,34,36–43] including all six self-paced interventions.[29,30,36,37,39,41] Electronic messaging-based BA interventions comprised 11%,

involving SMS or emails (n=2)[33,35] and the remaining 22% utilized telehealth to deliver BA interventions over the phone (n=4).[26,27,32,44]

Intervention components: Ten studies reported single-component digital BA interventions.[26,27,29,33–35,37–39,44] The remaining studies utilized a multi-component BA intervention. Three studies incorporated problem-solving therapy in addition to BA.[41–43] Two studies also included CBT[30,31] and one of these incorporated mindfulness in addition to CBT and BA.[30] One study utilized acceptance and commitment therapy with BA.[36] One study added the Health Action Process Approach (HAPA).[40] Lastly, one study utilized BA in addition to the 5 A's Model (Assess, Advise, Agree, Assist, and Arrange) to Coping with Chronic Illness.[32]

Table 2. Intervention characteristics.

Author (Year)	**Name**	**Technology**	**Components**	**Mechanisms of change**	**Dose**	**Guidance**	**Available Support**
Araya et al. (2021)[26]	N/A	Smartphone App	BA	Participating in meaningful activities	18 sessions / 6 weeks	Guided	Initial face-to-face meeting, app preinstalled on device, nurse assistants provided support and called patients twice at beginning, assistants called when system detected non-adherence, patients could request tech support
Birney et al. (2016)[22]	Moodhacker	Smartphone App	BA, CBT, Mindfulness	Added daily structure and reinforcement	6 weeks	Self-guided	Daily scheduled emails providing guidance, tips, and reminders
Buntrock et al. (2015)[30]	GET.ON	Web based	BA, PST	Participating in meaningful activities, problem solving	6 sessions over 3-6 weeks	Guided	Guidance provided by online trainers focus on supporting participants to work through the exercises. Participants communicate with their trainer trough the internal messaging function of the system on which the intervention is implemented.
Carlbring et al. (2013)[33]	Depressionshjälpen	Web based	BA, ACT	Participating in meaningful activities, diffusions, and values	7 weeks	Self-guided	Internet-therapist assisted with administration, reading and sending feedback to the

							participant
Choi et al. (2020)[24] Marti et al. (2021)[27]	N/A	Telehealth	BA	Participating in meaningful activities	5 weekly sessions	Guided	Telehealth
Dahne et al. (2023)[37]	Goal2Quit	Smartphone App	BA	Participating in meaningful activities	8 weeks	Self-guided	Help downloading app, and a brief overview on the app
Danaher et al. (2023)[29]	Mom Mood Booster	Web based	BA, CBT	Participating in meaningful activities, social support, mood tracking	12 weeks	Guided	Two scheduled calls for resolving difficulties and feedback
Ebert et al. (2014)[32]	Alles onder controle	Web based	BA, PST	Problem solving, coping skills, identifying important values	5 lessons	Guided	Feedback on modules completed
Guertler et al. (2023)[27]	Actilife	Electronic Messages	BA	Participating in meaningful activities, positive thinking, exercise, stress management, encouraging seeking help when needed	6 months	Guided	Not specified
Jelinek et al. (2020)[31]	N/A	Web based	BA	Mood tracking, participating in meaningful activities, problem solving	4 weeks	Self-guided	Provided in program
Ly et al. (2013)[34]	N/A	Smartphone App	BA	Daily structure, encourage social activities, participating in meaningful activities	8 weeks	Self-guided	Brief therapist contact
Ly et al. (2015)[35]	N/A	Hybrid (smartphone app / face to face)	BA	Positive thinking, positive reinforcement	9 weeks	Guided	Four in person BA sessions

Mueller-Weinitschke et al. (2023)[39]	InterAKTIV	Web based	BA, HAPA	Participating in meaningful activities, problem solving	8 weeks	Guided	Written semi-standardized feedback by an e-coach
Naik et al. (2019)[40]	Healthy Outcomes Through Patient Empowerment	Telehealth	BA, Goal Setting	Participating in meaningful activities, improving wellness, diet, physical activity, medication management, relaxation, problem solving	6 months	Guided	Active coaching
Nobis et al. (2015)[38]	GET.ON Mood Enhancer Diabetes	Smartphone App	BA, PST	BA, problem solving, diabetes management and concerns	6 sessions (1 session per week)	Guided	Assistance offered through phone call and email if no activity within 7 days
Sanabria-Mazo et al. (2023)[36]	N/A	Telehealth	BA	Participating in meaningful activities	8 weeks	Guided	Group therapy
Scazufca et al. (2023)[28]	Vida Vida	Electronic Messages	BA	Participating in meaningful activities, coping strategies	6 weeks	Guided	Tech support contact

Intervention delivery: Only six of the 17 digital BA interventions were self-paced, where participants could progress through the intervention at their own pace.[29,30,36,37,39,41] With the exception of two unguided and four self-guided interventions,[30,36,39,41] the interventions (n=11) were guided, meaning that they contained predetermined topics and materials based on a standard protocol and were delivered by trained nurses or research assistants.[26,27,31–35,38,40,42–44]

Only one intervention was delivered in a hybrid manner, with a smartphone app and in-person sessions delivered by M.Sc. Clinical Psychologist Program final-year students, who had completed their clinical training.[38] The interventions had a mean duration of approximately 8.1 weeks and a standard deviation of 7.3 weeks across all studies (n = 17).

Comparison

A majority of the studies were two-arm RCTs.[29–33,35,36,38–43] (see **Table 1** for details on comparison groups). Four studies were classified as three-arm RCTs[26,27,37,44] and one utilized two separate two-arm RCTs.[34]

Outcomes

All studies reported changes in depression symptoms as their primary outcome; except one[44] that reported it as a secondary outcome. The most commonly reported (≥ 6 studies) secondary outcomes included quality of life (QoL), functioning and disability, BA, and anxiety. These outcomes were reported at 2, 4, 6, 8, 10, 12, 20, 24, 36, 48, and 96 weeks. Across all studies, the mean outcome follow-up was 28.2 weeks with a standard deviation of 23.2 weeks.

Impact of digital BA interventions on outcomes: meta-analysis

The outcomes pooled in our meta-analysis included depression symptoms, anxiety, quality of life (QoL), BA, functioning and disability, and stress. All interventions were compared to the respective control groups.

Impact on Depression Symptoms at 2-, 3-, 6-, and 12-months: Only ten studies had sufficient data on depression symptoms for a meta-analysis. Of these studies, eight were iBA (one of which was a hybrid intervention), and the remaining two were one electronic messaging and one telehealth intervention. Three studies used a single component digital BA intervention,[35,38,39] while the remaining seven used multi-component interventions.[31,32,36,40–43] The intervention groups had statistically significant lower scores on depression surveys at 2 months[40,42] [n=360, p<0.00001, I^2=0%], 3 months[31,36,43] [n=605, p= 0.0010, I^2=51%], and at 6 months[32,35,38–41,43] [n=1290, p=0.009, I^2= 29%] follow-up. However, there were no significant differences at 12 months[32,35] [n=548, p=0.82, I^2=89%] follow-up.

Impact on BA at 6-months: BA was measured in three studies: one used a single component digital iBA intervention[34] while the other two utilized multi-component iBA interventions.[40,41] The intervention groups had significantly higher scores on BA surveys at 6 months[34,40,41] [n=1663, p=< 0.00001, I^2=0%)**]**.

Impact on Anxiety at 3-, and 6-months: Anxiety was measured in six studies. Three studies utilized single-component interventions[33,38,39] while the other three used multi-component interventions.[31,36,41] Five interventions used iBA (including one hybrid intervention) and the remaining intervention used electronic messaging. The intervention groups did not differ significantly on anxiety at either 3 months[31,33,36] [n=781, p=0.08, I^2=68%] or 6 months[38,39,41] [n=580, p=0.24, I^2= 44%] follow-up.

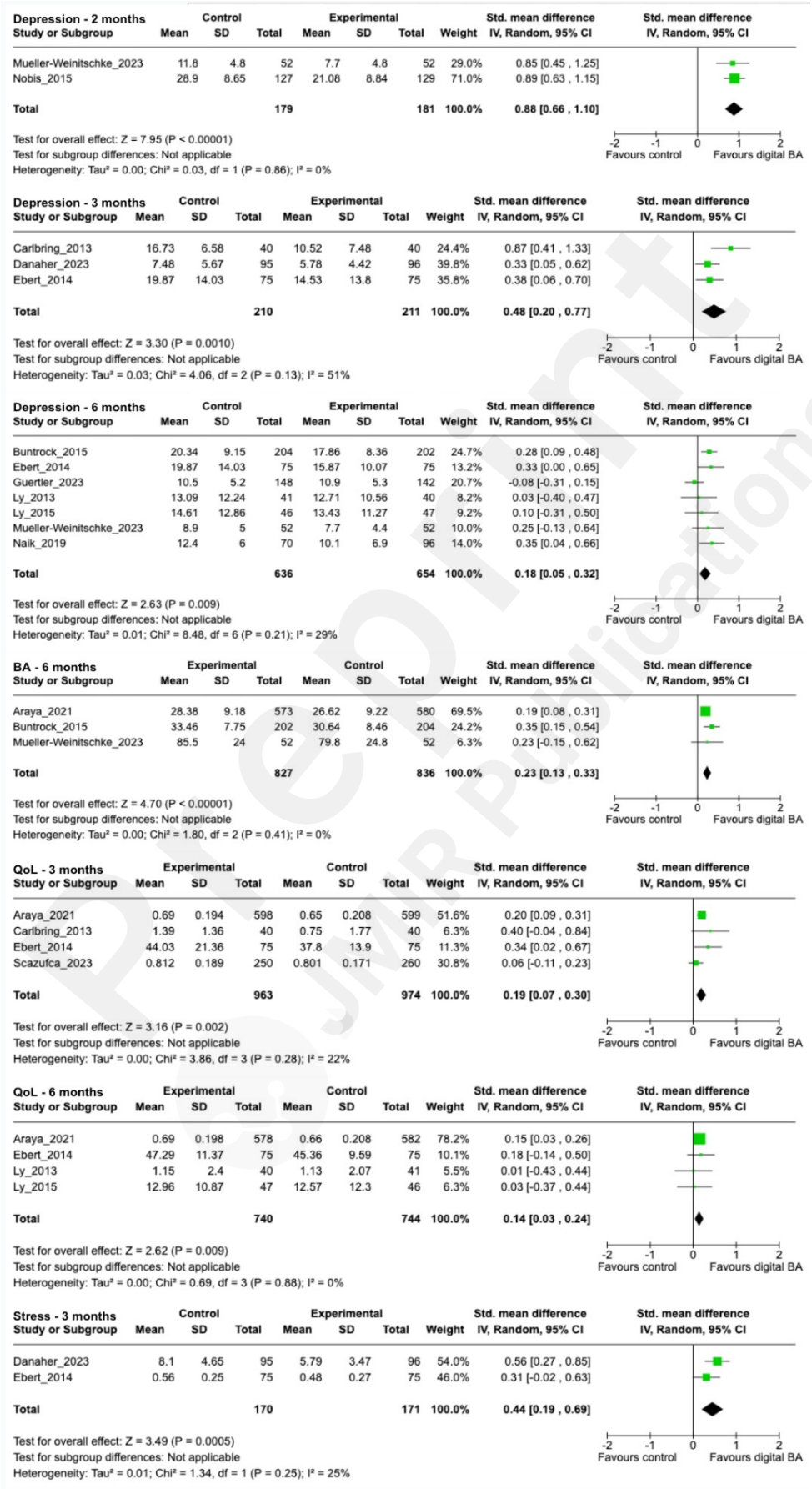
Impact on Quality of Life at 3-, and 6-months: Quality of life was assessed in six studies: four studies utilized single component interventions[33,34,38,39] while the remaining two used multi-component interventions.[36,43] Five studies used iBA (including one hybrid intervention) and the remaining used electronic messaging. The intervention groups had significantly higher scores on quality of life modules at 3 months[33,34,36,43] [n=1937, p=0.002, I^2=22%] and at 6 months[34,38,39,43] [n=1484, p=0.009, I^2= 0%] follow-up.

Impact on Functioning and Disability at 6-months: Two studies assessed functioning and disability: one used a single component iBA intervention,[34] while the other used a multi-component iBA intervention.[41] Intervention groups did not differ significantly compared to control groups on modules for functioning and disability at 6 months follow-up[34,41] [n=1942, p=0.88, I^2=90%].

Impact on Stress at 3-months: Two studies assessed stress, both of which utilized multi-component iBA interventions.[31,43] The intervention groups scored significantly lower on stress modules at 3 months[31,43] [n=341, p=0.0005, I^2=25%] follow-up.

Figure 2. Forest plot of outcomes with statistically significant differences: depression, BA, quality of life, stress. (see *Appendix S6* for forest plots of outcomes that showed no significant differences

between intervention and control groups)



Impact of digital BA interventions on outcomes: narrative synthesis

The six studies which were ineligible for inclusion in the meta-analysis are narratively summarized below.

In addition to BA, Birney et al.[30] explored the use of the MoodHacker mobile web app, a self-guided, multi-component iBA intervention utilizing CBT principles and mindfulness techniques to help working adults with mild-to-moderate depression. The study found significant improvements in depression symptoms, behavioral activation, and work-related outcomes at 6 weeks. However, effects were reduced at the 10-week follow-up, suggesting that sustained engagement and support are necessary for long-term efficacy.

Choi et al. [26] and its sister study Marti et al.[27] assessed the impact of a multi-component telehealth intervention for depressive symptoms in older adults with comorbid chronic conditions. They compared telehealth CBT, telehealth behavioral activation therapy (BAT), and a usual care control group. Both CBT and BAT significantly improved depressive symptoms and some physical health outcomes up to three months follow-up compared to the control. However, CBT showed more substantial long-term reductions in depressive symptoms than BAT. At the 12-month follow-up, neither intervention significantly affected disability, indicating that more specific interventions may be necessary for achieving meaningful improvements in physical health.

Jelinek et al. [37] evaluated the effects of a brief web-based behavioral activation module compared to mindfulness and TAU for individuals with mild depression. While the intervention led to an increase in activity and reduced dysfunctional attitudes, it did not result in a significant reduction in depressive symptoms during the 4-week follow-up.

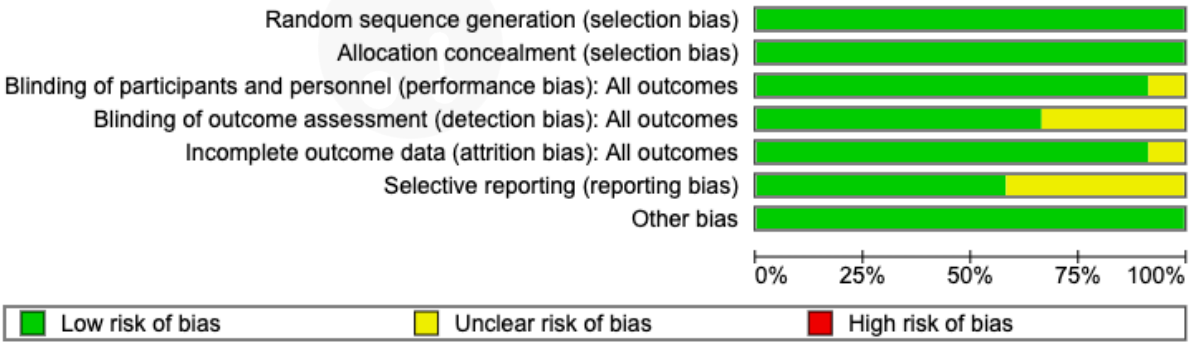
Sanabria-Mazo et al. [44] compared videoconference-delivered Acceptance and Commitment Therapy and Behavioral Activation Therapy for Depression for patients with chronic low back pain and comorbid depressive symptoms. Both interventions produced improvements in depressive symptoms, but neither had a significant impact on functional disability.

Dahne et al. [29] evaluated a mobile app-based BA intervention, "Goal2Quit," combined with nicotine replacement therapy for individuals with depressive symptoms who smoked. The intervention led to reductions in depressive symptoms and increased smoking cessation rates compared to standard self-help materials. Improvements in depression were most notable within the first three weeks, and smoking abstinence was significantly higher at weeks 4, 8, and 12.

Risk of bias of included studies

The risk of bias assessment detailed in **Figure 3** below revealed mixed levels of bias across the included studies.

Figure 3. RoB Summary.



The risk of bias was noted as unclear across some studies in the blinding of outcome assessment because these articles did not detail whether blinding of the outcome assessments was performed. However, all studies were judged to have a low risk of bias for allocation concealment and random sequence generation.

DISCUSSION

With increasing growth and accessibility to technology in tandem with the rise of mental health threats, this systematic review aimed to aggregate and evaluate recent empirical evidence on effectiveness of digital BA interventions designed to alleviate symptoms of depression and/or anxiety. Seventeen studies met our inclusion criteria, with twelve included in the meta-analyses.

Most of these studies were conducted in Europe, with the remaining studies being conducted in North and South America. This could be due to the fact that countries such as the UK have digital mental health interventions integrated into their country's National Health System.[45] iBA-based interventions were the most common type assessed in the review, potentially attributed to their relatively low cost and easy access as well as the their feasibility.[46]

Most interventions studied were single component interventions. Of the multi-component interventions, those utilizing BA in addition to problem solving therapy were the most common.

Our meta-analysis found that digital BA interventions significantly reduced depression symptoms at 2, 3, and 6 months, increased BA at 6 months, improved quality of life (QoL) at 3 and 6 months, and relieved stress at 3 months.

For the significant depression outcomes measured at 2, 3, and 6 months, most interventions were multi-component, combining behavioral activation with other therapeutic elements, such as CBT or problem-solving therapy, which may have contributed to their effectiveness. In particular, many interventions used internet-based BA (iBA), which has been shown to be effective at reducing depressive symptoms in prior review articles.[18,47] This combination of digital delivery, multiple therapeutic components, and various elements like psychoeducation and self-monitoring may explain the significant improvements observed.

BA was found to have a significant effect at 6 months. Two of the interventions[40,41] incorporated online feedback delivered to patients after each session and optional scheduled text messages to help establish what was discussed in their meetings. The third study[34] prompted nurse assistants to call participants who were not adhering to the intervention, as well as mandatory calls at the start. These three studies had mechanisms enabling participants to continue with the intervention through these systems of communication.

QoL was found to have significant improvement at 3 and 6 months. For QoL at three months, only one of the four studies utilized an intervention that was not targeted for a specific population.[36] Of the three studies that addressed specific populations, one study targeted a population with comorbid diabetes or hypertension,[34] both of which can alter QoL.[48] Another study targeted older adults in resource-limited situations,[33] which also has been shown to decrease QoL.[49] The last study targeted teachers,[43] which as an occupation has been shown to have correlations with decreased QoL.[50] Because these populations face unique challenges that can negatively impact their Quality of Life (QoL), tailored interventions may be more effective than general approaches. For instance, targeted strategies that help manage conditions like diabetes or hypertension or address the specific stressors of teachers or older adults in resource-limited settings can directly address these populations' unique needs. By focusing on the specific challenges affecting each group, these tailored interventions are positioned to yield greater QoL improvements than interventions designed for broader populations. This finding also holds with QoL at 6 months, which also had a significant effect. Two of the studies were the same as QoL at 3 months with targeted populations.[34,43] The other two studies, which were not found to have significant effects,[38,39] did not have a specific target study population.

The interventions showed a significant effect in reducing stress at 3 months. The two studies that assessed stress at this timepoint targeted specific populations: perinatal women[31] and teachers.[43] Given that these interventions were tailored to specific populations, they can be more focused on addressing relevant issues to help alleviate stress, compared to interventions targeting the general public.

The lack of significant effect on depression symptoms at 12 months suggests that benefits may

diminish once active treatment concludes. This could be due to the challenges associated with sustaining engagement with self-guided digital interventions over time. Factors such as reduced motivation, user fatigue, or the loss of novelty in using the app may contribute to the decline in intervention effects.[51] Research on digital therapeutics has identified these issues as common obstacles to long-term adherence and effectiveness. Additionally, the duration of follow-up may have influenced outcomes, as interventions that maintain contact with participants over extended periods may better sustain improvements.

There were no significant effects found for anxiety at 3 and 6 months. This could be due to the fact that all interventions were targeted at addressing depression symptoms as the primary outcome, leading to a lack of anxiety-specific components that could address symptoms like excessive worry or avoidance.[52]

There was no significant effect on functioning and disability at six months. This could be due to the fact that both interventions were targeted at addressing mental health, not physical health, and this may lead to minimal changes in overall physical health outcomes.[53]

Three interventions were further tailored to meet patient needs. For one group of patients that had depression and were smokers, the intervention, Goal2Quit, incorporated behavioral strategies for treating depression and quitting smoking using BA.[29] Another study analyzed the efficacy of the MomMoodBooster intervention which was tailored towards women with depression in the perinatal period.[31] The intervention specifically asked participants when they had delivered their baby in order to change from antepartum to postpartum program content. Another study assessing the efficacy of the Healthy Outcomes through Patient Empowerment for US veterans with uncontrolled diabetes specifically incorporated the 5 A's Model for coping with chronic illness.[32] Lastly, a similar study involving German patients with diabetes utilized the GET.ON Mood Enhancer Diabetes intervention which specifically included sessions between patients and interventionists focused on diabetes-specific themes including the link between diabetes and depression, worrying about diabetes problems, diabetes and sexuality, physical activity, and communication with general practitioners.[42]

The six studies included in the narrative synthesis collectively suggest that while digital interventions can be effective in reducing depressive symptoms in the short term, they often fall short in producing longitudinal improvements in physical health or functional disability. In the case of Jelinek et al.,[37] where no significant effects were found at the 4 week follow-up, the characteristics of the participant populations in these studies, such as mild baseline depressive symptoms or prior experience with similar treatments, may lead to limited room for improvement in functional outcomes The recurring theme across these studies is that mental health interventions, particularly when delivered remotely or in a brief format, tend to have a limited long-term impact on functional outcomes. The results suggest that to achieve longer lasting effects, these interventions may require higher dose, longer durations, more intensive engagement, or a greater emphasis on addressing the physical health aspects of comorbid conditions alongside mental health.

Potential Implications for Research

We have identified research gaps and opportunities for future work. *First*, the efficacy of these interventions at least one year after completion is difficult to discern. Long-term follow-up studies have shown that while some benefits of digital interventions for depression persist over time, the effects can diminish, and additional interventions might be necessary to maintain mental health improvements.[54,55] *Second*, the relative efficacies of single vs. multi-component digital BA interventions remain unclear. Although this meta-analysis highlighted that multi-component interventions, particularly those combining BA with other therapeutic approaches such as problem-solving therapy, often resulted in greater reductions in depressive symptoms, it is still necessary to delineate these effects to better understand the specific contributions of BA. Studies directly comparing single- and multi-component digital BA interventions could provide more insight into

which approach offers the most consistent and significant benefits across various populations.[56] *Third*, more research is needed to elucidate whether additional intervention tailoring, such as cultural adaptations, may produce more effective results in certain patient populations. Some studies included in this meta-analysis investigated the efficacy of these interventions on specific patient populations, such as those with chronic lower back pain, perinatal depression, or diabetes. Recent literature highlights the increased efficacy of culturally adapted digital mental health interventions among racial and ethnic minorities compared to control interventions that do not include cultural adaptations. As such, further research can better determine whether culturally-adapted digital BA interventions prove more effective at reducing depressive symptoms and anxiety in affected racial and ethnic minority populations.[57] *Fourth*, it may be worth exploring the use of artificial intelligence (AI)-based digital BA interventions, given the emerging utility of such advanced technologies. Recent studies suggest that AI can enhance personalized treatment by tailoring interventions based on individual patient data, potentially improving engagement and outcomes in mental health interventions. The integration of AI in digital BA interventions could enable real-time adjustments to treatment plans, offering a more dynamic and responsive approach to managing depression.[58] *Fifth*, more research assessing the clinical effectiveness of digital BA interventions in the US is needed. The majority of studies in this review were conducted in Europe, where digital mental health tools have been more readily integrated into healthcare systems, such as through the National Health Service in the UK.[59] This integration allows for routine use and evaluation of digital interventions, supported by policies that facilitate data sharing and interoperability with existing care pathways. In contrast, the US has faced slower adoption potentially due to the fragmented healthcare system and fewer centralized policies promoting digital mental health.[60] However, progress is being made, particularly with the introduction of FDA regulations for digital therapeutics, which are paving the way for more standardized and accessible digitally delivered treatments.[61] Addressing these barriers and conducting US-based studies could help establish the effectiveness and scalability of digital BA interventions in local healthcare contexts. *Sixth*, it is important to note the methodological limitations in the studies included. Survey tools such as the Patient Health Questionnaire (PHQ-9) and Behavioral Activation for Depression Scale – Short Form (BADS-SF) provide a simple and standard approach across all patient categories, but this also means that they may not fully capture the nuances of each individual patient to accurately assess their levels of depression, engagement with BA, or QoL. Additionally, it is possible that patients need additional time to adjust to using these interventions as part of their daily lives and to be fully effective in reducing their depressive symptoms. Alternative methods of measurement that can better assess each aspect of a patient with respect to their own baseline levels of functioning could produce more accurate results when assessing how an intervention can reduce depression symptoms or improve mood. Despite these limitations, digital BA interventions show promise in reducing depression symptoms and anxiety, increasing BA and QoL, and reducing stress. This meta-analysis provides an updated understanding of their utility and efficacy, but ongoing research is crucial as new studies and interventions continuously emerge. In summary, digital BA interventions represent a promising advancement in depression and anxiety treatment, offering accessible, scalable, and potentially effective options for individuals in diverse settings.

Review Strengths and Limitations

Our systematic review and meta-analysis are in accordance with PRISMA guidelines, incorporating independent ratings, sensitivity analyses, and an assessment of publication bias. The search strategy was specifically designed to capture a wide range of digital BA interventions, enhancing the thoroughness of our study. However, our approach is not without its limitations. *First*, the specificity of our search terms, which were tailored to identify interventions explicitly labeled as “behavioral activation,” may have resulted in the exclusion of relevant studies that used different terminology.

Despite this, the fact that we captured all studies in our validation set supports the robustness of our search approach. *Second*, we did not include unpublished research and restricted our search to studies published in English, potentially introducing a language and publication bias. *Third*, while our meta-analysis provided a detailed examination of the impact of digital BA interventions across various outcomes, the reliance on self-reported measures in most included studies raises concerns about the validity of these findings, particularly in the absence of external assessments of depressive symptoms. *Fourth*, interventions varied significantly in terms of their format, duration, and intensity, contributing to the observed heterogeneity in our analyses. This variability may have affected the comparability of results across studies. *Fifth*, the heterogeneity was reduced when interventions were categorized based on the level of guidance provided, suggesting that future meta-analyses might benefit from separating analyses by guidance level to achieve more consistent results. *Lastly*, the different follow-up periods across studies limited our ability to draw conclusions about the long-term efficacy of digital BA interventions. Grouping studies by post-measurement time points in future research could help provide more insight into the stability of intervention effects over time. Nevertheless, this meta-analysis contributes valuable evidence regarding the potential of digital BA interventions to reduce depressive symptoms and enhance mental health outcomes. These findings highlight the potential of digital BA as a scalable and accessible treatment option, offering practical implications for clinical practice and future research.

CONCLUSION

This systematic review and meta-analysis of digital BA interventions found a significant decrease in depression at 2, 3, and 6 months follow-up (post-intervention completion) but no significant decrease in depression at 12 months. Additionally, the meta-analysis found no significant decrease in anxiety at 3 or 6 months. However, the variability in the significance of depression outcome reductions are different timepoints post-intervention suggest a need for further research to determine the long-term efficacy and optimal structuring of these interventions. Future work should focus on understanding the long-term efficacy of digital BA interventions as well as a greater focus on edifying the differences between single and multi-component digital BA intervention approaches and cultural adaptability of these interventions to improve depression symptoms and anxiety.

AUTHOR CONTRIBUTIONS (CRediT Taxonomy)

Eric Jia, BS: Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing.
Jushawn Macon, BS: Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing.
Michelle Doering, MA: Search, Writing – Review & Editing.
Joanna Abraham, PhD: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Supervision.

COMPETING INTERESTS

The authors declare that they have no conflicts of interest in the research.

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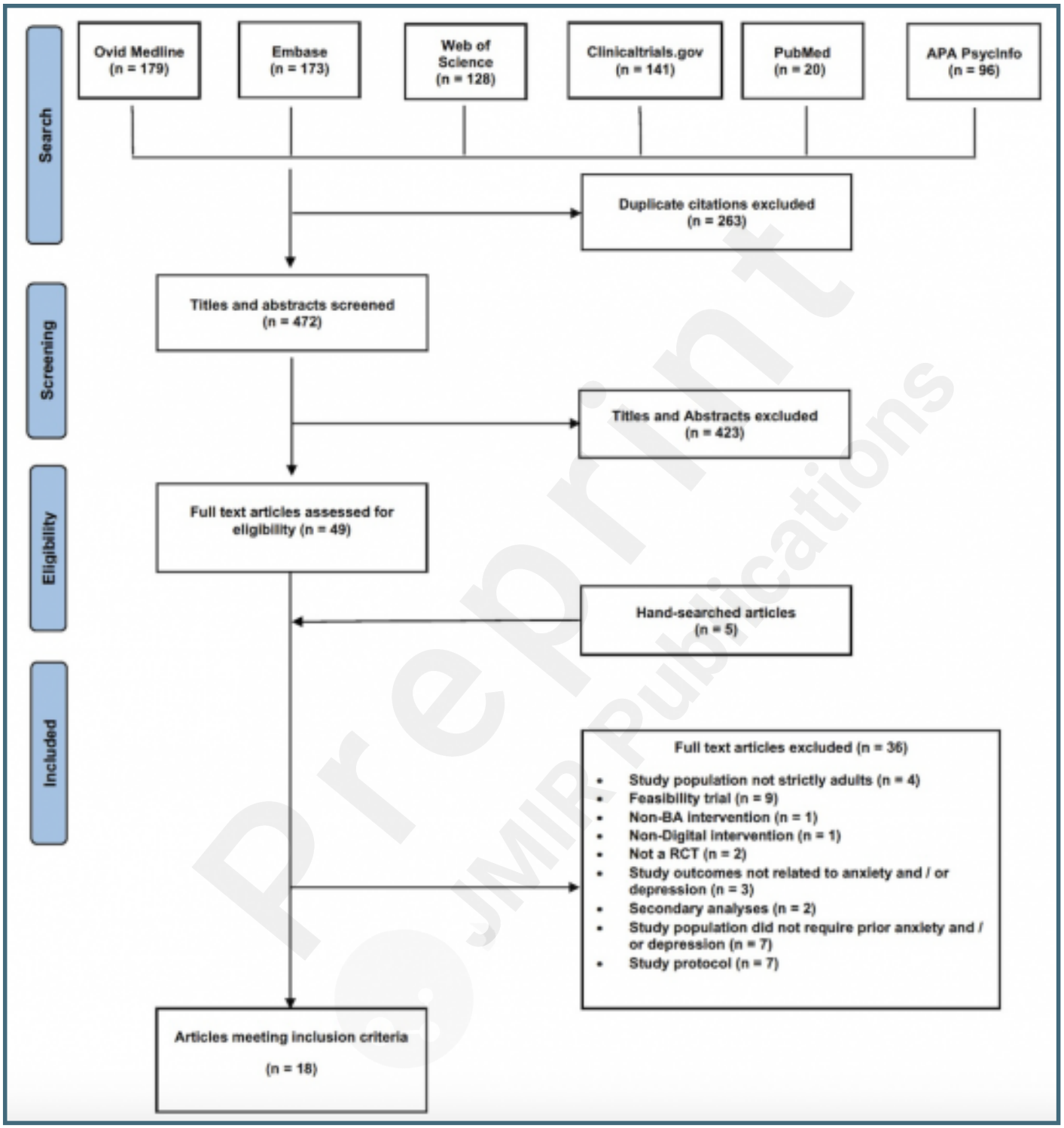
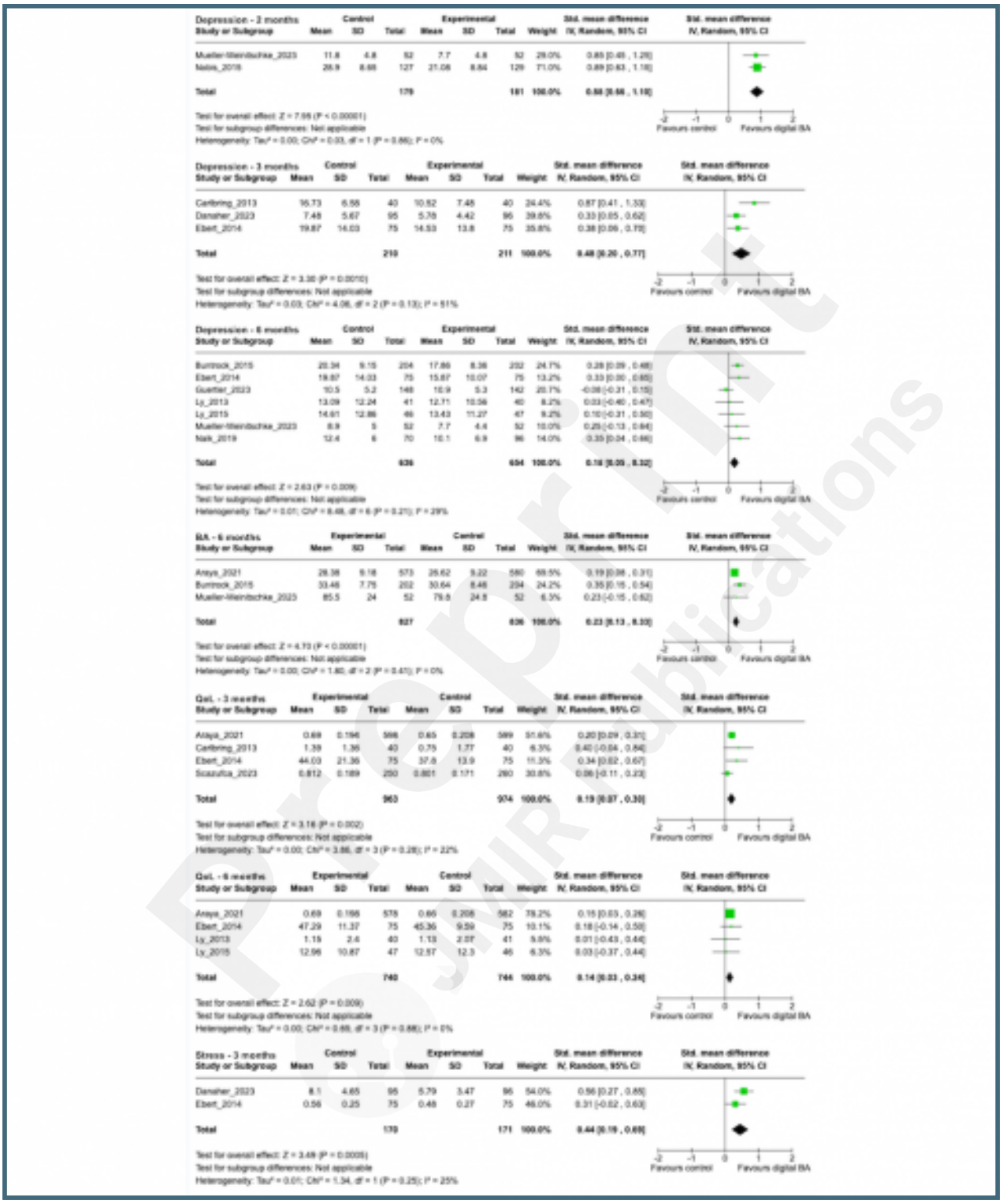
Supplementary Files

Figures

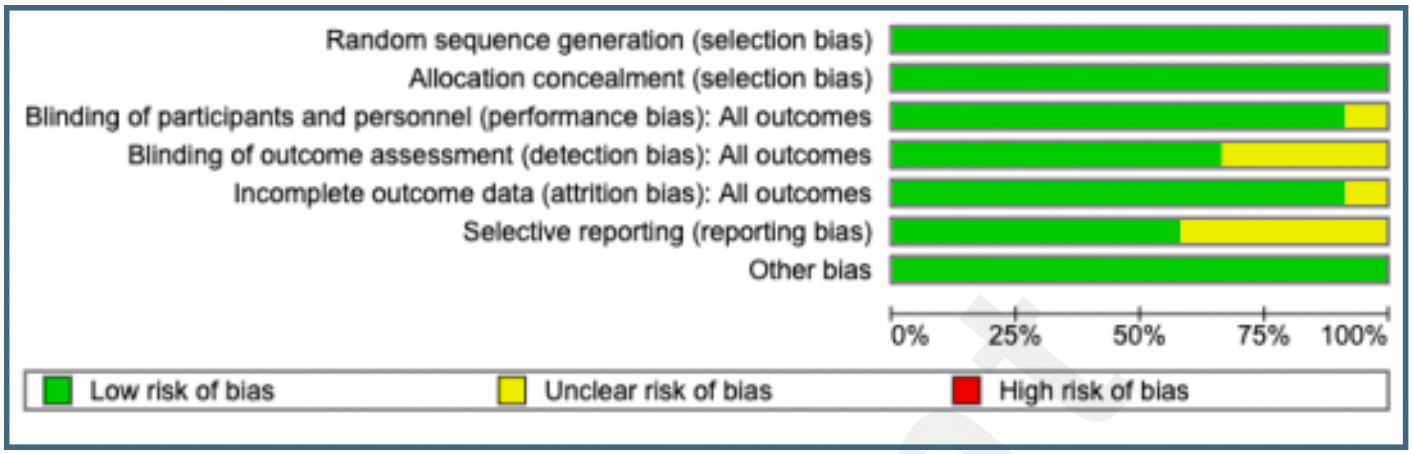
Study selection process.



Significant outcomes.



Risk of bias summary.



Multimedia Appendixes

Search strategies.
URL: http://asset.jmir.pub/assets/3abef45b4bc456954ce7bfbd1f04804e.docx

Inclusion criteria (PICO).
URL: http://asset.jmir.pub/assets/3abbce6437108982432b4d1a89142673.docx

Excluded studies.
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Data extraction template.
URL: http://asset.jmir.pub/assets/5e03e063039c08d82b407990cc1960db.docx

Definition of terms.
URL: http://asset.jmir.pub/assets/3936e0d70567b5be15a25ced42f595e6.docx

Forest plots of remaining insignificant meta-analysis outcomes.
URL: http://asset.jmir.pub/assets/a590a82c0de3ea7df41580bc158a7f1c.png