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Review article

Effectiveness of digital interventions for people with comorbid heavy drinking and depression: A systematic review and narrative synthesis

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ABSTRACT

Introduction: Heavy drinking and depression frequently co-occur and make a substantial contribution to the global non-communicable disease burden. Positive evidence exists for the use of digital interventions with these conditions alone, but there has been limited assessment of combined approaches.
Objective: A systematic review of the effectiveness of combined digital interventions for comorbid heavy drinking and major depression in community-dwelling populations.
Methods and analysis: Electronic databases were searched to October 2021 for randomised controlled trials that evaluated any personalised digital intervention for comorbid heavy drinking and depression. Primary outcomes were changes in quantity of alcohol consumed and depressive symptoms. Two reviewers independently assessed study eligibility, extracted data, and undertook risk of bias assessment. Due to the limited number and heterogeneity of studies identified, meta-analysis was not possible, therefore data were synthesised narratively.
Results: Of 898 articles identified, 24 papers were reviewed in full, five of which met the inclusion criteria (N = 1503 participants). Three utilised web-based intervention delivery; two computer programmes delivered in a clinic setting. All involved multi-component interventions; treatment length varied from one to ten sessions. Four studies found no evidence for the superiority of combined digital interventions for comorbid heavy drinking and depression over therapist-delivered approaches, single condition interventions (including online), or assessment-only controls. Positive impacts of integrated online therapy compared to generalist online health advice were reported in a fifth study, but not maintained beyond the 1-month follow-up.
Limitations: Few eligible, heterogeneous studies prevented meta-analysis.
Conclusion: Limited evidence exists of the effectiveness of combined digital interventions for comorbid heavy drinking and depression in community dwelling populations.

1. Introduction

Alcohol and depression make a substantial contribution to the global non-communicable disease burden (Lim et al., 2012; Whiteford et al., 2015). Alcohol consumption alone is causally related to over 60 different medical conditions (Rehm et al., 2009) and depression is a top three leading cause of disability and a relevant factor for excess all-cause mortality (Cuijpers and Smit, 2002; Cuijpers et al., 2014; Ferrari et al., 2014). Heavy drinking is also highly comorbid with major depressive disorders (Grant et al., 2015; Lai et al., 2015; Odlaug et al., 2016). Estimates of the prevalence of comorbid excessive drinking and depression vary; one study found 16% of people experiencing depression (range 5–67%) reported current, and 30% (range 10–60%) lifetime heavy drinking; around twice the rate found in the general population (7% and 16–24% respectively) (Sullivan et al., 2005). Experiencing these conditions co-morbidly is associated with poorer overall outcomes for the individual concerned. Heavy drinking is connected with: worsening the depression course, with risks of incident depression higher for heavier as

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opposed to lighter drinkers (Bellos et al., 2016); increased suicide risk (Rehm et al., 2017); and delayed recovery from psychiatric conditions (Greenfield, 2001).

Effective interventions exist for heavy drinking and depression when treated in isolation, including behavioural therapy delivered in primary health care (Carpenter et al., 2018; Kaner et al., 2018). For patients with co-morbid heavy drinking and depression, systematic reviews of the use of face-to-face cognitive behavioural therapy (CBT) and/or motivational interviewing MI have also demonstrated small but significant effects (Baker et al., 2012; Riper et al., 2014). However, translation of these interventions into routine practice remains low in global health systems, meaning few patients with heavy drinking and depressive disorders receive appropriate care (Patel et al., 2018). This evidence-to-practice gap is particularly evident in low and middle income countries (LMIC) (Chen et al., 2018), with low numbers of mental health specialists and limited resources for mental healthcare, highlighted as particular concerns (Bruckner et al., 2011; Esponda et al., 2020; Saxena et al., 2007).

Given emerging evidence of positive effect for the use of digital interventions with heavy drinking or depression alone, computerised and/or smartphone delivered advice and support could support the demand for flexible, more coordinated provision for patients experiencing such conditions co-morbidly (Andersson et al., 2014; Davies et al., 2014; Donker et al., 2013; Firth et al., 2017; Griffiths et al., 2010; Kampmann et al., 2016; Kaner et al., 2017; Khadjesari et al., 2011; Linardon et al., 2019; Riper et al., 2018). In LMIC populations especially, where health-care services face heightened resource, capacity and geographical challenges, digital interventions could provide new opportunities to support heavy drinkers with depression at scale, and at relatively low cost (Naslund et al., 2017). Recent research from Colombia and Peru suggests that tablet and/or app-based depression and alcohol screening and clinical guidance can be successfully implemented in primary health care, leading to increased rates of diagnoses, particularly for depressive disorders (Diez-Canseco et al., 2018; Torrey et al., 2020).

The international SCALA project (Scale-up of Prevention and Management of Alcohol Use Disorders and Comorbid Depression in Latin America, www.scalaproject.eu) seeks to test the impact of a range of strategies on rates of identification and support for heavy drinking patients with depression in primary health care in Colombia, Mexico, and Peru (Jane-Llopis et al., 2020). As part of the strategies being tested, the study will evaluate the use of telemedicine approaches and digital applications for implementing the clinical package where possible. To support this programme of work, we conducted a systematic review to assess the effectiveness of digital interventions at reducing co-morbid heavy drinking and depression in community-dwelling populations.

One existing systematic review has also focussed on this comorbid population, and reported positive effects for digital interventions at reducing depressive symptoms at 3-month follow-up and alcohol use at 6-month follow-up (Schouten et al., 2021). However, Schouten et al. included data from studies based on treatment-seeking individuals, the findings of which may not be transferable outside specialist health care settings. In this review therefore, we examine the evidence for community dwelling populations only, to better understand the potential contribution of digital interventions to supporting individuals with co-morbid heavy drinking and depression who have not previously engaged with treatment services.

2. Methods

2.1. Protocol and registration

Review methods, eligibility criteria, and strategy for data synthesis were determined in advance and reported in a published study protocol (Schulte et al., 2019). The systematic review was also registered at PROSPERO (registration number: CRD42019130134).

2.2. Eligibility criteria

Randomised controlled trials examining the impact of digital interventions on community-dwelling adults with co-morbid heavy drinking and depression were eligible for inclusion. Heavy drinking was defined as either hazardous drinking, a pattern of alcohol consumption that increases an individual's risk of harmful physical or psychological consequences (NICE, 2010), or harmful drinking, a pattern that is causing mental or physical damage (American Psychiatric Association, 2013; WHO, 2007). Depression was defined as either major depression disorder, persistent depressive disorder or clinical depression, assessed according to the World Health Organisation (WHO) ICD-10 classification of mental and behavioural disorders ICD-10 (WHO, 2007) or the Diagnostic and Statistical Manual of Mental Disorders (DSM–5) (American Psychiatric Association, 2013).

Studies were excluded if interventions were directed towards people who were seeking specialist health or social care for alcohol dependence and/or severe depression (such as in-patient/residential programmes), or who were in treatment for, or recovery from, alcohol dependence (e.g. 12-step programmes).

Only personalised digital interventions that provided feedback based on individual risk profile in response to user input were eligible for inclusion; defined as those delivered primarily through a programmable computer or mobile device (laptop, phone, or tablet). Primary outcomes of interest were quantity of alcohol consumed and change in depressive symptoms. Secondary outcomes included: number of drinking days; number of heavy drinking days; number of drinks per drinking day; number of days abstinent; total abstinence; time to relapse; quality of life; suicide-related behaviour; and any reported adverse effects. To be eligible for inclusion, studies needed to report primary outcomes for both alcohol consumption and depression.

2.3. Information sources

We searched the following electronic databases from inception to 31st October 2021 using a comprehensive search strategy designed in collaboration with an information specialist (FB): MEDLINE (Ovid); The Cochrane Library (Wiley); CENTRAL (Cochrane Central Register of Controlled Trials); CINAHL (EBSCO); Embase (OVID); PsycINFO (Ovid); ERIC (EBSCO); and SCI (Science Citation Index via Web of Knowledge). An example search strategy is provided in Appendix 1. There were no restrictions on date, publication status or language. Additionally, studies included in existing relevant systematic reviews were examined for eligibility, alongside a hand search of reference lists of all included studies. Where possible, authors were contacted directly to obtain additional and/or unpublished outcome data.

2.4. Study selection

Following de-duplication of the search results, two researchers independently screened all titles and abstracts (AOD, CS, MS, FB). The full texts of any studies identified as being potentially eligible were then similarly reviewed by two researchers (AOD, CS, MS), with any discrepancies resolved by discussion or consulting a third researcher as necessary (BS, EK).

2.5. Data extraction

A standardised data extraction form was specifically developed and piloted for this study. Data were extracted on: (1) study identifiers (first author, year of publication, country; (2) study design; (3) participant characteristics (age, gender, sample size); (4) details of the intervention (including mode of delivery); (5) primary and secondary outcomes (mean scores, standard deviations, drop-outs/adherence, outcome instruments); and (6) information for the assessment of the risk of bias. If there was more than one possible outcome, a hierarchy established in

advance in the study protocol was followed (Schulte et al., 2019). Two researchers carried out data extraction of each included study independently (AOD, CS), with any discrepancies resolved by a third researcher (BS, EK).

2.6. Data synthesis

A meta-analysis was not conducted due to the small number of included studies and the heterogeneity of outcomes employed. Data were summarised in tables, with results synthesised narratively based on SWiM (Synthesis Without Meta-analysis) reporting guidance (Campbell et al., 2019) and using harvest plots (Ogilvie et al., 2008). Harvest plots are a graphical method for displaying data on the overall pattern of evidence from a systematic review (Foulds et al., 2021). In harvest plots, each intervention is represented by a vertical bar, and the properties of the bar represent characteristics of the study. As others have reported, compared to meta-analysis, this method is particularly useful for synthesising results from trials of complex behavioural interventions, as it allows the inclusion of all relevant data, irrespective of differences in study characteristics or outcome measures (Petticrew et al., 2013), and has been used previously in reviews of substance use interventions (Garcia-Huidobro et al., 2018). Three researchers (AOD, BSc, FB) independently assessed the risk of bias of the included studies using Cochrane's revised tool for assessing risk of bias in RCTs (RoB2) (Sterne et al., 2019).

3. Results

We identified 898 potentially eligible articles after electronic deduplication. 874 articles were excluded at the title and abstract screening stage, resulting in 24 papers for full-text review. Of these, 19 papers were subsequently excluded. Reasons for exclusion included: ineligible study design; lack of appropriate primary outcome measures; ineligible participant criteria employed; and ongoing trial. Five articles relating to five separate studies were therefore included in the narrative synthesis (Baumgartner et al., 2021; Deady et al., 2016; Geisner et al., 2015; Kay-Lambkin et al., 2011, 2009).

See Fig. 1 for the PRISMA flowchart of the selection of studies and Appendix 2 for details of studies excluded at full text stage and reason.

3.1. Description of included studies

A total of 1503 participants (882 males) were involved in the included studies (Baumgartner et al., 2021; Deady et al., 2016; Geisner et al., 2015; Kay-Lambkin et al., 2011, 2009). Across the included studies, the mean age of participants was 32.01 (range: 17 to 70 years old, SD not presented). All studies were conducted in high income countries: three in Australia (Deady et al., 2016; Kay-Lambkin et al., 2011, 2009); one in the United States of America (Geisner et al., 2015); and the most recent, in Switzerland, Germany and Austria (Baumgartner et al., 2021).

In Kay-Lambkin et al. (2009), referrals of potential participants to the study were sought from other drug, mental health and primary health-care settings. Participants were also drawn from the general community in response to advertising through the local television and print media (Kay-Lambkin et al., 2009). In their later trial, most participants self-referred in response to advertisements promoting the study. Other referrals came from public drug outpatient or mental health

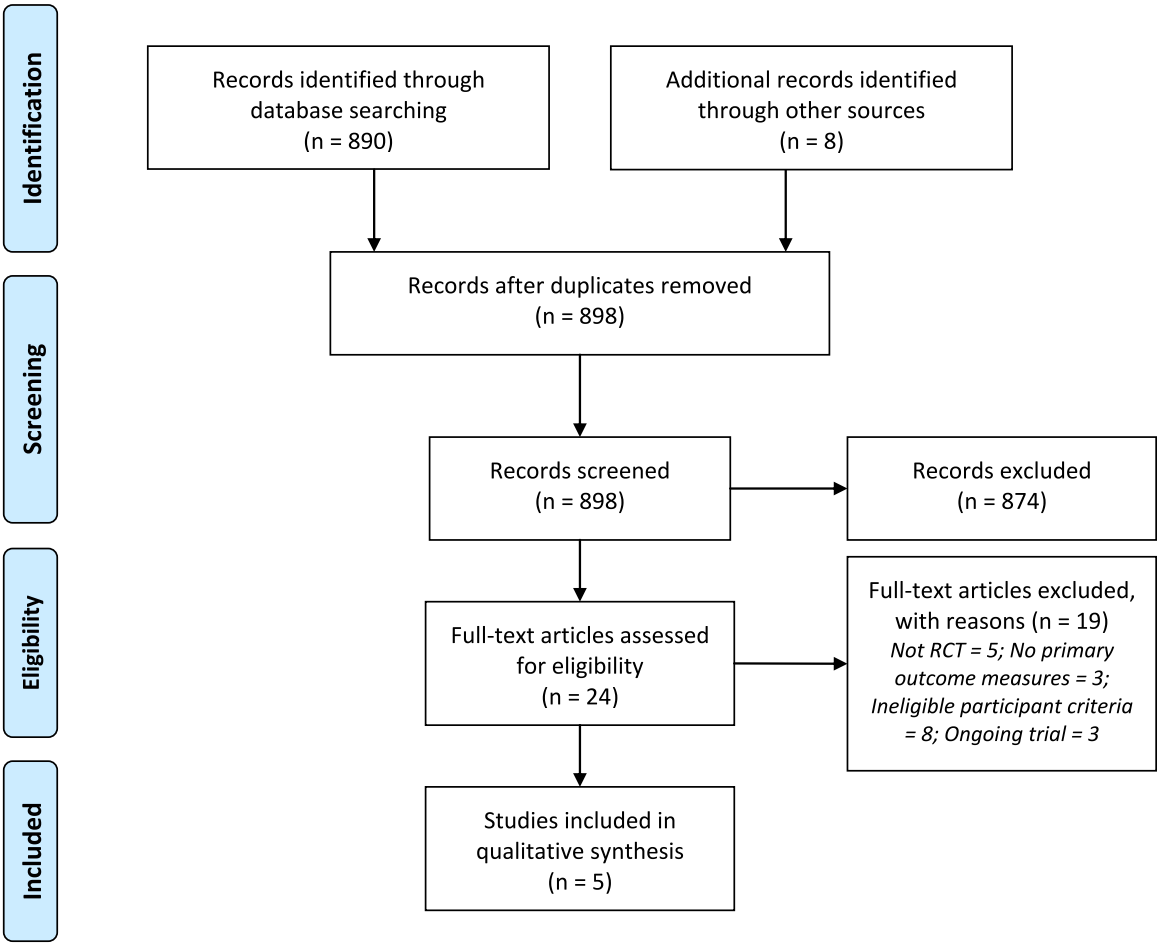

Fig. 1. Prisma flowchart.

facilities, primary care, and employment services (Kay-Lambkin et al., 2011). Students based at a large, public university in the Pacific Northwestern United States comprised participants in Geisner et al. (2015) (Geisner et al., 2015). Deady et al. (2016) recruited participants using extensive media coverage, including University flyers and street press, radio and newspaper stories, treatment services websites, and paid Facebook and Google advertisements (Deady et al., 2016). Participants in the Baumgartner et al. trial were recruited through two websites (www.takecareofyou.ch, www.alkcoach.at), advertisements in relevant internet forums and newspapers, and search engine website advertisements (Baumgartner et al., 2021).

Two trials led by Kay-Lambkin compared a clinician assisted computer-based intervention to a time-equivalent (i.e. comparable length and number of intervention sessions) face-to-face intervention (Kay-Lambkin et al., 2011; Kay-Lambkin et al., 2009). The 2011 Kay-Lambkin study also included an additional face-to-face arm using person-centred therapy (PCT) as opposed to CBT or MI based support (Kay-Lambkin et al., 2011). Geisner compared an integrated digital intervention for both heavy drinking and depression with alcohol (control 1) and depression (control 2) only interventions (Geisner et al., 2015). Deady compared the performance of a digital intervention focussed on addressing heavy drinking and depression specifically with a generalist health promotion advice control arm (Deady et al., 2016). Baumgartner compared an integrated web-based intervention for alcohol use and depression with an alcohol-only intervention of comparable length (Baumgartner et al., 2021). Three studies also compared the digital intervention against a minimal or no treatment arm: Baumgartner et al. (2021) provided an unblinded waitlist control group with general psycho-educative information and access to the internet as usual; Geisner et al. (2015) used a type of assessment-only control; and Kay-Lambkin et al. (2009) delivered a brief single session face-to-face intervention to the control group, which was also delivered to all experimental groups.

Three utilised web-based delivery (Baumgartner et al., 2021; Deady et al., 2016; Geisner et al., 2015) and two involved computer programmes delivered in a clinic setting with clinician assistance (Kay-Lambkin et al., 2011, 2009). All interventions included personalized feedback (either provided digitally or face-to-face), were based on cognitive behavioural therapy and/or motivational interviewing, and combined multiple components, such as psychoeducation, protective or coping strategies, drink reduction and refusal, goal setting, behavioural activation and others. Treatment length varied substantially across trials: eight online modules, with one to two modules to be completed each week plus weekly semi-automated motivational emails (Baumgartner et al., 2021); a single session plus five weekly e-mail reminders to log in again (Geisner et al., 2015); four weekly, one-hour sessions (Deady et al., 2016); and 10 weekly, one-hour sessions (Kay-Lambkin et al., 2011, 2009). Detailed characteristics of the included studies are provided in Table 1 with a table summarising the content of interventions available in Appendix 3.

3.2. Risk of bias and methodological quality of studies

Quality assessment suggested there were some concerns of risk of bias in all included studies. These included programming errors leading to an imbalance in group randomisation (Deady et al., 2016); lack of pre-published protocol (Geisner et al., 2015); and high rates of missing outcome data for participants (Baumgartner et al., 2021; Kay-Lambkin et al., 2011, 2009) (see Fig. 2, full details in Appendix 4).

3.3. Effectiveness of included interventions

Kay-Lambkin et al. (2009) evaluated the clinician-assisted computer-based SHADE program and found comparable reductions in alcohol consumption in both intervention and control groups (Kay-Lambkin et al., 2009). At the 12-month follow-up point (main outcome), the therapist-delivered SHADE control group (control group 2) showed higher mean reductions in alcohol consumption compared to both the brief intervention-only control (control group 1) and the computer-based intervention group; however, this difference was not statistically significant.

Both the clinician-assisted computer-delivered SHADE intervention group and the therapist-delivered SHADE control group (control group 2) showed comparable improvements in depressive symptoms at month 12, representing a reduction of approximately 14 points in the average BDI-II score (Kay-Lambkin et al., 2009). This was higher than the BI-only control group (control group 1), where an average reduction of only eight points was reported. However, these effects varied by group over time. The therapist-delivered SHADE group (control group 2) reported the greatest impact on depressive symptoms at follow-up point month three, followed by a considerable relapse between months six and 12. No comparable relapse in symptoms was found in the computer-based SHADE intervention group; however smaller improvements were accrued over time (interaction between quadratic trend and therapist versus computer conditions, $p < 0.001$).

In Kay-Lambkin et al's subsequent study (2011), the clinician-assisted computer-based SHADE program (intervention group) was compared against a therapist-delivered SHADE group (control group 1) and a therapist-delivered Person Centered Therapy (PCT) group (control group 2) at the three-month follow-up point (Kay-Lambkin et al., 2011). In bivariate group comparisons, both SHADE programmes (computer-based intervention group and therapist-delivered control group 1) were found to be superior to the PCT group (control group 2) in terms of reducing alcohol consumption. When results of both therapist-delivered interventions were combined (control groups 1 and 2), the clinician-assisted computer-based SHADE intervention yielded higher drinking reductions. However, results of a multivariate regression found no significant difference between intervention and controls at the same time point (computer versus both therapist groups, $p = 0.083$). The proportion of patients reporting at least a 50% reduction in alcohol consumption was higher in both clinician-assisted computer-based (intervention) and therapist-delivered (control group 1) SHADE programme groups (both groups combined 41% vs. 17% in PCT, $p = 0.028$; computer vs. both therapist interventions: 45 vs. 28%, $p = 0.002$).

The study also found significantly reduced depressive symptoms (BDI-II score) at the three-month follow-up in both clinician-assisted computer-based (intervention) and therapist-delivered (control group 1) SHADE programme groups compared to those receiving PCT (control group 2) (Kay-Lambkin et al., 2011). However, again, multivariate regression analyses found no significant differences between (clinician-assisted) computer- and therapist-delivered groups. Additionally, no significant differences were found between groups in the proportion of either patients without depression or reporting at least a 50% reduction in symptoms at the three-month follow-up point. In a multivariate regression analysis, group allocation also failed to achieve statistical significance (both SHADE-treatments vs. PCT: $p = 0.064$); however, the authors found that a change in alcohol use predicted a change in depression.

Geisner et al. (2015) compared the impact of four different conditions on college students' alcohol consumption: an integrated online intervention targeting both depression and alcohol (intervention group); an alcohol-only intervention (control group 1); a depression-only intervention (control group 2); and assessment-only (control group 3) (Geisner et al., 2015). After one-month, comparable reductions in alcohol consumption were observed in all four groups, with no statistically significant differences found after controlling for gender, racial background, or baseline drinking levels. Likewise Geisner et al. (2015) failed to detect any meaningful reductions in depressive symptoms in either the intervention or three control groups at the one-month follow-up point (Geisner et al., 2015).

Deady et al. (2016) evaluated an online integrated intervention for heavy drinking and depression (DEAL Project, also based on

Table 1
Summary characteristics of included studies.

Author (Year) Country	Sample	Inclusion criteria	Baseline assessment	Intervention	Control Group(s)
Kay-Lambkin et al. (2009) Australia	*N* = 97 Mean age = 35.37 (18–61) Male = 46%	Consuming daily average 4+ (men)/ 2+ (women) drinks[1]. Beck Depression Inventory-II score ≥17 and/or DSM-IV-based diagnosis of major depressive disorder.	120 min face-to-face clinical assessment	*Computer-based intervention (clinician-assisted):* 1 One-session face-to-face manualized brief intervention that included feedback from assessment, MI, brief advice, and self-help materials 2 9 x weekly sessions of CBT/MI therapy over 3 months (SHADE program) followed by face-to-face 10–15 min 'check-in' with research clinician.	*Control group 1 (face-to-face):* 1 One-session face-to-face manualized BI that included feedback from assessment, MI, brief advice and self-help materials 2 No further treatment *Control group 2 (face-to-face):* 1 One-session face-to-face manualized BI that included feedback from assessment, MI, brief advice and self-help materials 2 9 x weekly sessions of therapist-delivered CBT/MI therapy over 3 months (SHADE program).
Kay-Lambkin et al. (2011) Australia	*N* = 274 Mean age = 40 (17–70) Male = 57%	Consuming daily average 4+ (men) /2+ (women) drinks[1]. Beck Depression Inventory-II score ≥17.	60–120 min (approx.) face-to-face clinical assessment	*Computer-based intervention (clinician-assisted):* 1 One-session face-to-face manualized brief intervention that included feedback from assessment, MI, brief advice, and self-help materials 2 9 x weekly, 60 min sessions of CAC therapy, consisting of integrated CBT/MI delivered by a computer, followed by face-to-face 10–15 min 'check-in' with research clinician.	*All participants:* One-session face-to-face manualized brief intervention that included feedback from assessment, MI, brief advice, and self-help materials + *either* *Control group 1 (face-to-face):* 9 x weekly, 60 min sessions of integrated CBT/MI, content identical to CAC but therapist-delivered. *Control group 2 (face-to-face):* 9 × 60 min sessions of PCT, consisting of therapist-delivered supportive counselling.
Geisner et al. (2015) USA	*N* = 339 Mean age = 20.14 (SD 1.34) Male = 37.6%	Consuming 4+ (women)/ 5+ (men) drinks[2] on ≥1 occasion in past month and AUDIT score ≥8. Beck Depression Inventory-II score ≥14.	15 min online screening survey + 45 min online baseline interview	*Integrated intervention (web-based):* 1 Personalized feedback on both alcohol consumption and depressive symptoms 2 Protective strategies: reinforcement of strategies already used by the participants and suggestion of further strategies 3 More in-depth psychoeducation on the relationship between alcohol and depression 4 Referral list of treatment resources	*Control group 1 - alcohol-only (web-based):* 1 Personalized feedback on drinking behaviour 2 Suggested protective behaviours and reinforcing existing ones; 3 Brief psychoeducation on relationship between alcohol and depressed mood, without directly targeting mood symptoms, 4 Referral list of treatment resources *Control group 2 - depression-only (web-based):* 1 Personalized feedback on self-reported depressive symptoms; 2 Suggested protective behaviours and reinforcing existing ones 3 Referral list of treatment resources *Control group 3 - assessment- only (web-based):* 1 Referral list of treatment resources for depression and substance use.
Deady et al. (2016) Australia	*N* = 104; Mean age = 21.74 (SD 2.22); Male = 40%	AUDIT score ≥ 8 DASS-21-Depression score ≥ 7.	15–30 min (approx.) online assessment	*Integrated intervention (web-based):*4 × 1 h modules over 4-weeks (based on SHADE program): 1 Psychoeducation, assessment, goalsetting, and monitoring; 2 Behavioural activation, decisional balance, and behavioural change; 3 Mood monitoring and cognitive restructuring; 4 Coping with tough situations: mindfulness, relaxation, problem solving, drink reduction, refusal/ relapse planning and management.	*Control group - HealthWatch attention (web-based):* 1 4 × 1 h modules over 4-weeks comprising: environmental health; physical and mental activity; nutrition; and relationships.
Baumgartner et al. (2021) Switzerland, Germany, and Austria	*N* = 689; Mean age = 42.8 (SD 11.7);	AUDIT score ≥ 8 centre for Epidemiologic Studies Depression Scale [CES-D] score ≥ 10	~20 min (approx.) online assessment	*Integrated intervention (web-based):*8 x modules over 6-weeks with personal e-companion, study forum and adherence focussed e-coach.	*Control group 1 – alcohol only (web-based):*8 x modules over 6-weeks with personal e-companion, study forum and adherence focussed e-coach (comparable

(*continued on next page*)

Table 1 (*continued*)

Author (Year) Country	Sample	Inclusion criteria	Baseline assessment	Intervention	Control Group(s)
	Male = 51.7%			1 Introduction to consumption diary, drinking pros/cons, motives/ confidence to change 2 Goalsetting/associated strategies; habit changing 3 Positive mood activities; tips for common problems 4 Depression and problems; goals 5 Understanding and dealing with craving 6 Dealing with slips 7 Meeting your needs; sleep; social contacts 8 Preserving success	length to intervention). 1 Introduction to consumption diary, drinking pros/cons, motives/ confidence to change 2 Goalsetting and associated strategies; habit changing 3 Saying 'no'; tips for common problems 4 Identifying risk situations 5 Understanding and dealing with craving 6 Dealing with slips 7 Progressive muscle relaxation 8 Preserving success *Control group 2 – internet access as usual (IAU)*Waitlist control group with access to relevant internet resources

[1] Standard Australian drink contains 10 g ethanol (Australian Government Department of Health, 2020).
[2] Standard USA drink contains 14 g ethanol (NIAAA, 2021). Key: BI = brief intervention; MI = Motivational Interviewing; CBT = Cognitive Behavioural Therapy; Clinician-assisted computerised (CAC); PCT = person-centred therapy.

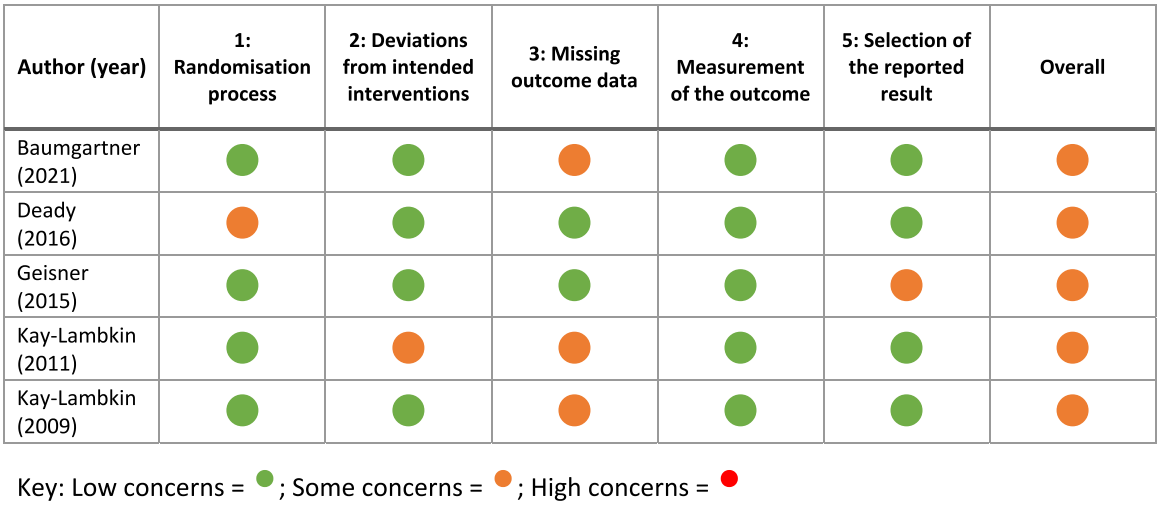

Fig. 2. Risk of bias assessment.

Kay-Lambkin's SHADE programme) (Deady et al., 2016) against a general health promotion online control of equivalent length. At the one-month follow-up point, they found a significantly greater reduction in alcohol consumption in the intervention group compared to control. However, the superiority of the DEAL group was no longer evident at the three or six-month follow-up points. Similarly, although the intervention group achieved greater short-term reductions in depressive symptoms compared to controls, this superiority was not maintained over time, as the control group showed increasing improvement in symptoms at months three and six post-intervention.

The most recent trial from Baumgartner et al. (2021) compared the performance of an integrated web-based intervention for alcohol use and depression with an alcohol-only intervention of comparable length and an internet access only waitlist control. At both the three- and six-month follow-up points, they found comparable reductions in alcohol use in the integrated intervention group and alcohol only control; both being significantly greater than the internet access only control. Similarly, the integrated intervention group and alcohol only control achieved comparable reductions in depression scores (as measured by the CES-D (Centre of Epidemiologic Studies of Depression Scale)(Devins et al., 1988)); and again, these were significantly greater reductions than reported for the internet access only control group (Baumgartner et al., 2021). See Table 2 for full results and Fig. 3 for the associated harvest plots summarising results against our primary outcome measures across all studies.

3.4. Secondary outcomes

3.4.1. Number of drinking days

Deady et al. (2016) also reported impact on frequency of drinking and found a significantly higher short-term reduction (one-month) in the intervention group compared to the control group (Deady et al., 2016). However, this difference was not evident at either the three- or six-month follow-up points. Baumgartner et al. (2021) also reported on the number of drinking days and found significantly greater reductions in the alcohol only control group compared to the internet access only control group at the six-month follow-up point. However, there was no significant difference in the reduction of drinking days in the integrated intervention group, compared to internet access only controls (Baumgartner et al., 2021).

3.4.2. Abstinence

Kay-Lambkin et al. (2011) found a higher percentage of abstinent patients at month three in the digital intervention group (13%)

Table 2
Impact of included interventions on primary outcomes.

Author (Year)	Measure	Follow-up timepoint	Number of subjects (all groups)	Results	Summary
Quantity of alcohol consumed					
Kay-Lambkin et al. (2009)	Opiate Treatment Index (OTI) score, reflecting mean number of drinks per day averaged over past month Converted into g/wk using 10 g per drink	12 months	$n = 41$	Mean reductions relative to baseline: intervention group: 224.7 g/wk; control group 1 (BI only): 290.5 g/wk; control group 2 (Therapist): 497.7 g/wk. No differences between BI-only controls and computer intervention for alcohol consumption: standardized change score (ES) difference of 0.01. Therapist- versus computer-delivered intervention: ES of 0.36, in favour of therapist-delivered treatment[1].	• Moderate to large reductions in all groups. • Largest reductions in therapist-delivered intervention group • Differences not statistically significant between groups.
		3 months	$n = 41$	Mean reductions relative to baseline: intervention group: 247.1 g/wk; control group 1 (BI only): 237.3 g/wk; control group 2 (Therapist): 421.4 g/wk	
		6 months	$n = 41$	Mean reductions relative to baseline: Intervention group: 66.5 g/wk; control group 1 (BI only): 123.9 g/wk; control group 2 (Therapist): 418.6 g/wk	
Kay-Lambkin et al. (2011)	Opiate Treatment Index (OTI) score: mean reduction in drinks per day compared to baseline Converted into g/wk using 10 g per drink	3 months	$n = 168$	*Comparison: Computer* vs. *Therapist:* Intervention group: 427.7 g/wk; both therapist groups collapsed: 168.0 g/wk. $F_{1,167} = 7.875$; $p = 0.006$. *Comparison: SHADE* vs. *PCT:* Both SHADE intervention groups collapsed: 341.6 g/wk; PCT group: 72.1 g/wk; $F_{1,167} = 8.333$; $p = 0.004$	• Both digital and therapist-delivered SHADE interventions superior over PCT. • Largest reductions in digital intervention group.
Geisner et al. (2015)	Drinks per week, converted into g/wk using 14 g per drink	1 month	$N = 311$	Comparable drinking reductions in all groups: integrated Intervention: 55.7 g/wk; alcohol-only intervention: 29.5 g/wk; mood-only intervention: 63.1 g/wk; assessment-only controls: 38.8 g/wk. No significant main effects of intervention condition on weekly drinking ($F = 1.51$, $p = 0.54$), after controlling for gender, racial background, and baseline drinking levels.	Comparable reductions in all groups. Differences not statistically significant.
Deady et al. (2016)	Drinks per week, assessed with TOT-AL. Converted into g/wk using 8 g per drink	1 month	$N = 104$ ($n = 56$[2])	Statistically significant between-group-difference in reduction from baseline (RR= 0.62, 95% CI 0.39–1.00; $P = 0.05$) Mean reductions relative to baseline: intervention group: 111.4 g/wk; control group: 4.3 g/wk	• Largest reduction in digital intervention group compared to control.
		3 months	$N = 104$ ($n = 45$[2])	No group difference ($p > 0.5$) Mean reductions relative to baseline: intervention group: 126.9 g/wk; control group: 51.8 g/wk	• Differences not statistically significant between groups.
		6 months	$N = 104$ ($n = 40$[2])	No group difference ($p > 0.9$) Mean reductions relative to baseline: Intervention group: 78.7 g/wk; control group: 27.7 g/wk	• Differences not statistically significant between groups.
Baumgartner et al. (2021)	Drinks per week assessed with 7-day timeline followback (TLFB) Converted in g/wk using 15 g per drink	3 months	$N = 689$ ($n = 332$[3])	Mean reductions relative to baseline: integrated intervention group: 261 g/wk; control group 1 (alcohol only): 314 g/wk; control group 2 (internet access only): 213 g/wk Significantly greater reduction in integrated intervention group compared to control group 2 (internet access only) ($p = 0.013$). Significantly greater reduction in control group 1 (alcohol only) compared to control group 2 (internet access only) ($p < 0.001$) No significant difference between integrated intervention and control group 1 (alcohol only) ($p = 0.206$).	• Significantly greater reduction in integrated intervention compared to control group 2 (internet access only) • Comparable reduction in integrated intervention and alcohol only control.
		6 months	$N = 689$ ($n = 289$[3])	Mean reductions relative to baseline: intervention group: 248 g/wk; control group 1 (alcohol only): 297 g/wk; control group 2 (internet access only): 198 g/wk Significantly greater reduction in integrated intervention group compared to control group 2 (internet access only) ($p = 0.048$). Significantly greater reduction in alcohol only	• Significantly greater reduction in integrated intervention compared to control group 2 (internet access only) • Comparable reduction in integrated intervention and alcohol only control.

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Table 2 (*continued*)

Author (Year)	Measure	Follow-up timepoint	Number of subjects (all groups)	Results	Summary
				control intervention group, compared to control group 2 (internet access only): ($p = 0.004$) No significant difference between integrated intervention and control group 1 (alcohol only) ($p = 0.366$).	
Change in depressive symptoms					
Kay-Lambkin et al. (2009)	Beck Depression Inventory-II (BDI-II)	12 months	$n = 67$	Mean reductions relative to baseline (BDI-II score points): intervention group: 14.9; control group 1 (BI only): 8.1; control group 2 (Therapist): 14.6 Standardized change score (ES) differences: intervention vs. BI-only: 0.27; therapist intervention vs. BI-only: 0.36.	• Moderate to large reductions in all groups. • Digital intervention and therapist-delivered intervention were superior to BI-only control. • Differences not statistically significant between groups.
		3 months	$n = 67$	Mean reductions relative to baseline (BDI-II score points): intervention group: 11.5; control group 1 (BI only): 9.9; Control group 2 (Therapist): 21.9	
		6 months	$n = 67$	Mean reductions relative to baseline (BDI-II score points): intervention group: 11.9; control group 1 (BI only): 4.6; control group 2 (Therapist): 19.5	
Kay-Lambkin et al. (2011)	Mean reduction in BDI-II score, compared to baseline	3 months	$N = 274$	Mean reduction in BDI-II score: 6.87 [both SHADE intervention groups collapsed] vs. 3.84 [PCT group]; $F_{1,273} = 5.164$; $p = 0.024$. No difference when comparing the computer intervention vs. both therapist interventions.	• Digital and therapist-delivered SHADE intervention were superior to PCT control. • Differences not statistically significant between groups.
Geisner et al. (2015)	Beck Depression Inventory-II (BDI-II) scores	1 month	$N = 311$	No relevant reduction in mean depression levels in either of the groups Mean reductions relative to baseline (BDI-II score points): integrated Intervention: 1.5; alcohol-only intervention: 2.2; mood-only intervention: 2.4; assessment-only controls: 1.0 No significant main effects of intervention condition on depression ($F = 0.81$, $p = 0.78$), after controlling for gender, racial background, and baseline depression levels.	Small reduction in all groups. Differences not statistically significant between groups.
Deady et al. (2016)	PHQ-9 scores	1 month (post treatment)	$N = 104$ ($n = 56$[2])	The improvement in the treatment group was 4.51 points greater than in the control group (beta= –3.89, 95%CI –7.09 to –0.68; $d = 0.71$, $p = 0.02$). Mean reductions relative to baseline (PHQ-9 score points): intervention group: 5.94 (95% CI: 3.70 - 8.18); control group: 1.43 (95% CI:0.60 - 3.46)	• Largest reduction in digital intervention group compared to control.
		3 months	$N = 104$ ($n = 45$[2])	Both groups improved post-baseline (within-group effect between baseline and 3-month follow-up for the treatment group was $d = 0.96$ and $d = 0.67$ for the control group), no group difference ($p > 0.5$) Mean reductions relative to baseline (PHQ-9 score points): intervention group: 5.93 (95% CI: 3.37 - 8.53); control group: 4.21 (95% CI:1.15 - 7.27)	• Both groups improved. • Differences not statistically significant between groups.
		6 months	$N = 104$ ($n = 40$[2])	Both groups improved post-baseline (within-group effect between baseline and 6-month follow-up was $d = 1.42$ for the treatment group and $d = 0.78$ for the control group), no group difference ($p > 0.3$) Mean reductions relative to baseline (PHQ-9 score points): intervention group: 7.53 (95% CI: 4.55 – 10.51); control group: 4.82 (95% CI:1.36 - 8.28)	• Both groups improved. • Differences not statistically significant between groups.
Baumgartner et al. (2021)	Centre of Epidemiologic Studies of Depression Scale [CES-D]	3 months	$N = 689$ ($n = 332$[3])	Mean reductions relative to baseline (CES-D scores): integrated intervention group: 6.33; control group 1 (alcohol only): 6.73; control group 2 (internet access only): 3.15. Significantly greater reduction in integrated intervention group compared to control group 2 (internet access only): $d = 0.35$ (95% CI: 0.16 - 0.53) Significantly greater reduction in control group 1 (alcohol only) compared to control group 2 (internet access only): $d = 0.36$ (95% CI: 0.17 - 0.53)	• Significantly greater reduction in integrated intervention compared to control group 2 (internet access only) • Comparable reduction in integrated intervention and alcohol only control.

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Table 2 (*continued*)

Author (Year)	Measure	Follow-up timepoint	Number of subjects (all groups)	Results	Summary
		6 months	$N = 689$ ($n = 289$[3])	No significant difference between integrated intervention and control group 1 (alcohol only). Mean reductions relative to baseline (CES-D scores): intervention group: 6.67; control group 1 (alcohol only): 7.3; control group 2 (internet access only): 2.66. Significantly greater reduction in integrated intervention group compared to control group 2 (internet access only): $d = 0.41$ (95% CI: 0.22 - 0.59) Significantly greater reduction in control group 1 (alcohol only) compared to control group 2 (internet access only): $d = 0.43$ (95% CI: 0.24 - 0.61) No significant difference between integrated intervention and control group 1 (alcohol only) ($p = 0.890$).	• Significantly greater reduction in integrated intervention compared to control group 2 (internet access only) • Comparable reduction in integrated intervention and alcohol only control.

[1] Statistical significance not reported but unlikely to be significant due to small sample sizes.
[2] Missing data handled using the generalized estimating equations approach (GEE).
[3] Missing data handled using multiple imputation procedures with Markov chain Monte Carlo techniques.

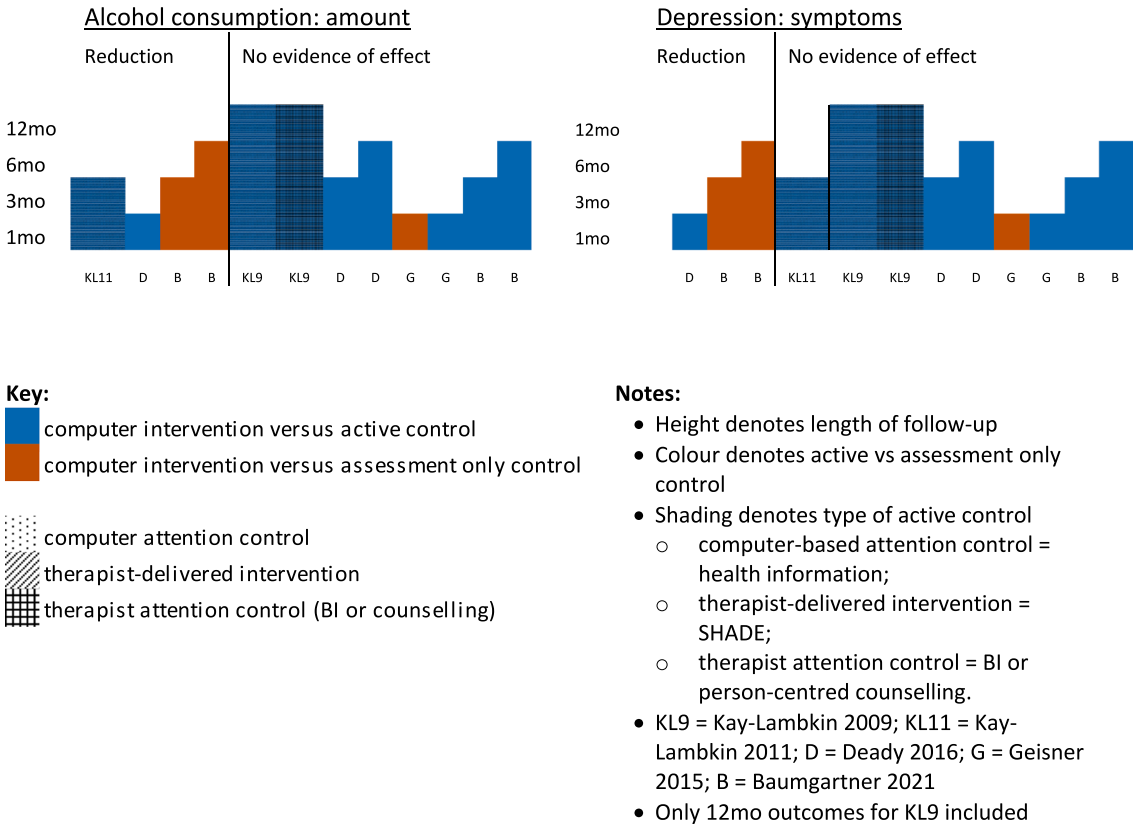

Fig. 3. Harvest plot of primary outcomes.

compared to both control groups (5%) (Kay-Lambkin et al., 2011). However, this difference was not statistically significant ($p = 0.057$).

3.4.3. *Alcohol-related consequences*

Geisner et al. (2015) assessed alcohol-related consequences using the Rutgers Alcohol Problem Index (RAPI) (Geisner et al., 2015). All groups, including assessment-only controls, reduced the number of alcohol-related consequences at the one-month follow-up point (on average, between 5 and 6 fewer consequences than at baseline, see Table 3), with no significant differences between groups after controlling for gender, racial background and baseline levels ($F = 1.51$, $p = 0.28$). However, participants with lower baseline depression levels (one SD below the sample mean) appeared to benefit from the intervention. In this subgroup, predicted values of alcohol-related consequences at follow-up were significantly lower in the alcohol only intervention and integrated intervention group (approximately nine and 10 consequences respectively) compared to the assessment-only control condition (approximately 17 consequences), after controlling for gender, racial background, and baseline number of consequences.

Table 3
Impact of included interventions on pre-specified secondary outcomes.

Author (Year)	Measure	Follow-up timepoint	Number of subjects (all groups)	Results	Summary
Number of drinking days per week					
Deady et al. (2016)	Drinking days per week	1 month	$N = 104$ ($n = 56$[1])	Statistically significant between-group-difference in reduction from baseline (RR=0.63, 95% CI 0.43–0.93; $d = 0.76$; $P = 0.02$). Mean reductions relative to baseline: intervention group: 1.4 drinking days/wk; control group: 0.2 drinking days/wk	• Digital intervention superior to control group
		3 months	$N = 104$ ($n = 45$[1])	No group difference ($p > 0.2$) Mean reductions relative to baseline: intervention group: 1.4 drinking days/wk; control group: 0.7 drinking days/wk	• Differences not statistically significant between groups.
		6 months	$N = 104$ ($n = 40$[1])	No group difference ($p > 0.4$) Mean reductions relative to baseline: intervention group: 0.9 drinking days/wk; control group: −0.03 drinking days/wk	• Differences not statistically significant between groups.
Baumgartner et al. (2021)	Drinking days per week according to 7-day timeline follow-back (TLFB)	3 months	$N = 689$ ($n = 332$[2])	Significance values for between group differences not reported. Mean reductions relative to baseline: intervention group: 1.15 drinking days/wk; control group 1 (alcohol only): 1.75 drinking days/wk; control group 2 (internet access only): 0.84 drinking days/wk.	Greatest difference in alcohol only control group.
		6 months	$N = 689$ ($n = 289$[2])	Significant group difference between control group 1 (alcohol only) and control group 2 (internet access only) ($p = 0.005$); no group difference between intervention and control group 2 (internet access only) ($p = 0.120$) Mean reductions relative to baseline: intervention group: 1.4 drinking days/wk; control group 1 (alcohol only): 1.9 drinking days/wk; control group 2 (internet access only): 0.9 drinking days/wk.	Alcohol only group performed significantly better than control.
Abstinence					
Kay-Lambkin et al. (2011)	Percentage of patients abstinent	3 months	$N = 168$	Both SHADE groups vs. PCT: 8% vs. 6%, n.s. Computer vs. both therapist interventions: 13% vs. 5%, n.s. ($p = 0.057$)	• Non-significant trend towards superiority of digital intervention
Alcohol-related consequences					
Geisner et al. (2015)	Rutgers Alcohol Problem Index (RAPI)	1 month	$N = 311$	Comparable reductions in all groups: Mean reductions relative to baseline (number of consequences): Integrated Intervention: 6.5; Alcohol-only intervention: 7.0; Mood-only intervention: 6.3; Assessment-only controls: 4.7 No significant main effects of intervention condition on alcohol-related consequences ($F = 1.51, p = 0.28$) after controlling for gender, racial background, and baseline depression levels.	Differences not statistically significant between groups.
Alcohol use disorder severity					
Baumgartner et al. (2021)	AUDIT-C Score	3 months	$N = 689$ ($n = 332$[2])	Mean reductions relative to baseline: intervention group: 4.24; control group 1 (alcohol only): 5.32; control group 2 (internet access only): 1.12. Significantly greater reduction in integrated intervention group compared to control group 2 (internet access only): $d = 0.51$ (95% CI: 0.31 - 0.68) Significantly greater reduction in control group 1 (alcohol only) compared to control group 2 (internet access only): $d = 0.71$ (95% CI: 0.51 - 0.89)	Comparable performance for integrated and alcohol only groups, significantly higher than internet only control.
		6 months	$N = 689$ ($n = 289$[2])	Mean reductions relative to baseline: intervention group: 5; control group 1 (alcohol only): 6.18; control group 2 (internet access only): 1.66. Significant difference between both integrated intervention group and control group 2 (internet access only): $d = 0.54$, 95% CI: 0.35 - 0.72, $p = 0.003$. Significant difference between control group 1 (alcohol only) and control group 2 (internet access only): $d = 0.81$, 95% CI: 0.61 - 0.99, $p < 0.001$). No significant difference between intervention group and control group 1 (alcohol only) ($p = 0.313$)	Comparable performance for integrated and alcohol only groups, significantly higher than internet only control.
Mental distress					
Baumgartner et al. (2021)	Mental Health Inventory – short version (MHI-5).	3 months	$N = 689$ ($n = 332$[2])	Significance values for between group differences not reported. Mean reductions relative to baseline: intervention group: 12.23; control group 1 (alcohol only): 12.84; control group 2 (internet access only): 6.77.	Scores reduced in all groups
		6 months			

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Table 3 (*continued*)

Author (Year)	Measure	Follow-up timepoint	Number of subjects (all groups)	Results	Summary
			$N = 689$ ($n = 289$[2])	Comparable reductions in all groups. Mean reductions relative to baseline: intervention group: 12.47; control group 1 (alcohol only): 13.41; control group 2 (internet access only): 7.32.	Differences not statistically significant between groups.

[1] Missing data handled using the generalized estimating equations approach (GEE).
[2] Missing data handled using multiple imputation procedures with Markov chain Monte Carlo techniques.

3.4.4. Alcohol use disorder severity

Baumgartner et al. (2021) assessed alcohol use disorder severity using the AUDIT-C questionnaire and found comparable performance for both the integrated intervention and alcohol only control groups, with significantly greater reductions compared to the internet access only control at both three- and six-months.

3.4.5. Mental distress

The short version of the Mental Health Inventory (MHI-5) tool (Cuijpers et al., 2009) was used by Baumgartner et al. (2021) to measure mental distress at both follow-up points. They reported that MHI-5 scores reduced in all groups at both time points, with no significant differences found between groups (as measured at six-months).

4. Discussion

This review identified a small and inconclusive evidence base for the effectiveness of combined digital interventions for heavy drinking and depression in community dwelling populations. Out of the five eligible RCTs, all of which were conducted in high income developed countries, only the trial from Deady et al. found a greater reduction in both alcohol and depression outcomes in the digital intervention group compared to control, but this was only in the short-term, at the one month follow-up point (Deady et al., 2016). The remaining four trials reported reductions in alcohol consumption and depressive symptoms in all treatment groups but found limited or no evidence for the superiority of combined digital interventions for heavy drinking and depression over therapist-delivered approaches, single condition interventions, or assessment-only controls. Two of these reported comparable performance for the digital and therapist-delivered versions of the same combined intervention (Kay-Lambkin et al., 2011, 2009). However, studies from Geisner and Baumgartner that compared time-equivalent integrated versus single condition online interventions did not find superiority for the combined depression and alcohol approach (Baumgartner et al., 2021; Geisner et al., 2015); including comparable impacts on outcomes not explicitly targeted by the single condition intervention (i.e. the alcohol-only intervention had similar effects on depression symptoms as the integrated version).

We are aware of one other recently published review that also examined the effectiveness of combined digital interventions for a comparable patient population (Schouten et al., 2021). In contrast to our assessment of the available evidence, Schouten et al. concluded that digital interventions are effective in reducing depressive symptoms at three-month follow-up and alcohol use at six-month follow-up amongst people with comorbid depression and heavy drinking. It is important to emphasise that the present review differs in that we excluded studies that focussed on delivery of digital interventions to formerly dependent drinkers; these were primarily designed to support patient recovery after leaving residential specialist treatment and as such concerned with maintaining abstinence as opposed to reducing consumption (Agyapong et al., 2012; O'Reilly et al., 2019). Here, we included only interventions targeted at community-dwelling participants, where intervention goals focussed on reducing drinking to within lower risk levels, alongside reducing symptoms of depression, and where participants could include heavy drinking individuals not currently in contact with or seeking treatment from general or specialist healthcare providers. This distinction is important given that digital interventions have been proposed as a means of boosting access to heavy drinkers known for low engagement with conventional healthcare settings, such as younger adults (Kaner and Bewick, 2011).

We also concluded that meta-analysis was neither possible nor appropriate, due to: the methodological limitations of the evidence; the lack of appropriately disaggregated data reported in eligible studies; the varied outcome measures employed; and the substantial heterogeneity in both the interventions and participants. Interventions ranged from a single online session to a programme of clinician-assisted computer-sessions delivered over multiple weeks. Participants were recruited in different settings and reported varied baseline drinking levels. For example, Geisner et al. (2015) recruited college students with baseline drinking levels of around 250 gs of alcohol per week (Geisner et al., 2015), substantially lower than the participants in Kay-Lambkin et al. (2009) study who reported baseline drinking levels of around 600 gs of alcohol per week (Kay-Lambkin et al., 2009). As such, we considered it was inappropriate to meta-analyse this small and heterogeneous evidence base and instead chose to present a detailed narrative review of the content and focus of the included studies, to inform future research in this field, with harvest plots used to graphically display trends.

The small and inconclusive evidence base identified here also contrasts with the results of several published systematic reviews examining the impact of digital interventions on either depression or heavy drinking alone. For depression alone, findings suggest that digital interventions are both effective and acceptable for adults experiencing depressive symptoms, including in routine practice (Andrews et al., 2018; Karyotaki et al., 2018; Königbaue et al., 2017; Sin et al., 2020). Likewise, existing reviews of the effectiveness of digital interventions for excessive drinking suggest moderate-quality evidence that they are effective in reducing mean weekly alcohol consumption and in achieving adherence to low-risk drinking limits (Black et al., 2016; Kaner et al., 2017; Nair et al., 2015; Riper et al., 2018). Our results also differ from reviews of the effectiveness of combined face-to-face therapies for heavy drinking and depression, which report small but positive results compared with treatment as usual, and which actually strengthened over time in the case of alcohol-consumption outcomes (Baker et al., 2012; Riper et al., 2014). However, as with face-to-face interventions for heavy drinking, given the lack of between group differences reported in Geisner et al. (2015), our findings do suggest potential for assessment reactivity in their online counterparts, i.e. that simply asking participants about their consumption may serve as an intervention in itself (Schrimsher and Filtz, 2011).

Given the size and quality of the evidence identified in this review, it is challenging to draw conclusions as to which characteristics of combined digital interventions appear more (or less) likely to support reductions in alcohol consumption and symptoms of depression. The four trials that suggested superior or at least equivalent performance for combined digital approaches were all based on a similar package of 'ingredients' (SHADE intervention) and involved multiple and relatively lengthy sessions with programme users (four x one hour sessions in DEAL, 10 x one hour sessions in SHADE, and eight online modules with the latest Baumgartner trial, see Appendix 4) (Baumgartner et al., 2021; Deady et al., 2016; Kay-Lambkin et al., 2011, 2009). Whilst we did not

conduct a comprehensive behaviour change technique analysis of these interventions (Michie et al., 2013), some elements common to both effective face-to-face and digital intervention, such as goal setting, self-monitoring and implementing protective strategies (Garnett et al., 2018; Michie et al., 2012) were evident in the included interventions. It is also notable that the most recent Kay-Lambkin trial suggested superior performance for interventions based on CBT over those using PCT approaches for both alcohol and depression outcomes (Kay-Lambkin et al., 2011). The remaining study from Geisner et al. compared the performance of single-session, web-based interventions targeting either drinking only, mood only, or integrated drink and mood (Geisner et al., 2015), meaning participants would have likely spent much less time engaging with the intervention and related homework compared to the lengthier SHADE-based programmes evaluated by Kay-Lambkin, Deady, and colleagues, or the substantial online programme tested by Baumgartner et al.

4.1. Strengths and limitations

The strengths of this systematic review include the use of a comprehensive search strategy, building on techniques previously employed in comparable Cochrane Collaboration reviews (Kaner et al., 2017; Shinohara et al., 2013). All titles, abstracts and full text papers were independently screened by two reviewers, and we employed a robust approach to quality assessment (Sterne et al., 2019). One key limitation concerns the small number of eligible studies identified, representing a small number of participants overall (1503 across all five trials). The primary reasons that several studies were excluded were either ineligible participants (e.g. targeting patients that were in- or post-treatment as opposed to non-dependent drinkers in community settings) and ineligible study design (e.g. pre-post as opposed to RCT). We identified two protocols for potentially eligible ongoing trials but were unable to obtain appropriate data to inform this review (Cunningham et al., 2018; Musiat et al., 2019). As described above, an additional limitation was that the included studies were highly heterogeneous in terms of the interventions tested, the participant populations, and the outcome measures employed. Additionally, we were unable to disaggregate data sufficiently from either of the Kay-Lambkin trials (Kay-Lambkin et al., 2011, 2009), meaning it was not possible to conduct the planned meta-analysis, an issue highlighted in previous reviews in this field (Hobden et al., 2018).

Participant characteristics also varied across studies, further limiting comparison. For example, participants in the trial from Geisner et al. reported lower baseline depression scores than those in the other included studies (Geisner et al., 2015), and the moderator analysis carried out in this study suggested that there was a difference in alcohol consequence outcomes (although not consumption outcomes) for those with lower depression scores. In contrast, participants in the Kay-Lambkin studies reported higher levels of alcohol consumption at baseline, however these studies did not report alcohol consequence outcomes. The control conditions used in each trial also varied substantially, making it challenging to unpack and compare effect sizes. For example, only three studies included what was effectively an assessment only control (Baumgartner et al., 2021; Geisner et al., 2015; Kay-Lambkin et al., 2009). All five studies compared a combined digital intervention with time-equivalent control interventions. In three studies, these time-equivalent controls were also delivered online, but had different content; either targeted at a single condition only (Baumgartner et al., 2021; Geisner et al., 2015) or comprising general health promotion advice (Deady et al., 2016). In both Kay-Lambkin trials, the computer-based interventions tested against therapist-delivered interventions of comparable content (Kay-Lambkin et al., 2011, 2009). Attrition rates were similar across all three fully online trials (Baumgartner et al., 2021; Deady et al., 2016; Geisner et al., 2015), with 50% upwards of participants lost at each follow-up point. Nevertheless, this represents a relatively good engagement rate for an online trial (Linardon, 2020), suggesting these digital interventions are feasible and acceptable for younger and middle-aged participants at least.

4.2. Implications for practice and future research

The limited and inconclusive evidence identified in this review means it is not possible to derive implications for clinical practice from these results. At the same time, the ongoing COVID-19 pandemic has highlighted the valuable role that digital health interventions can play in helping to increase access to mental health and substance use support (Chew et al., 2020; Torous et al., 2020). Whilst the evidence presented here is inconclusive, it is important to note that the results of Kay-Lambkin's trials suggest that clinician-assisted computerized approaches may have comparable results to effective therapist-delivered combined interventions, especially when delivered in multiple sessions over a longer time period (Kay-Lambkin et al., 2011, 2009). As previously mentioned, the most recent Kay-Lambkin study found that computer-based interventions using CBT were more effective in this population than those using PCT approaches; other research by this group also suggests positive impacts of CBT on suicidal ideation and hopelessness compared to PCT (Handley et al., 2013). Looking forward, more trials are needed, that employ methodologically rigorous research designs, and compare the performance of interventions of differing intensities and content, potentially using CBT, to better inform our understanding of which digital approaches can best address co-occurring heavy drinking and depression, and how these may be successfully implemented in routine clinical care (Hobden et al., 2018; McHugh and Weiss, 2019).

There is also a need for future studies to be conducted in more varied geographic contexts. Whilst epidemiological data suggest higher rates of depressive and alcohol use disorders are experienced in populations living in wealthier regions, they pose an increasing public health challenge for LMICs (Ferrari et al., 2014; Saxena et al., 2007; Shield et al., 2020; Thornicroft et al., 2017). Development and implementation of digital health interventions could help address the rising demand for treatment and prevention services in these regions, but to be feasible will need to be relatively brief, simple and low-tech (many have access to only basic technology, can afford limited data plans and face instability in the local power supply (O'Donnell, 2020). Finally, future reviews could also consider expanding the eligibility criteria to include a wider range of study designs and participants with more severe symptom profiles.

5. Conclusion

There is limited and inconclusive evidence of the effectiveness of combined digital interventions for co-morbid heavy drinking and depression that are appropriate for use in community dwelling populations. More methodologically rigorous trials are needed, comparing the performance of interventions of differing intensities and content, and conducted in more diverse geographical contexts, to better inform our understanding of which digital approaches can best address co-occurring heavy drinking and depression in future.

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Not required.

CRediT authorship contribution statement

Amy O'Donnell: Visualization, Methodology, Writing – review & editing. **Christiane Sybille Schmidt:** Visualization, Methodology, Writing – review & editing. **Fiona Beyer:** Visualization, Data curation, Methodology, Writing – review & editing. **Margret Schrietter:** Visualization, Methodology, Writing – review & editing. **Peter Anderson:** Writing – review & editing. **Eva Jane-Llopis:** Writing – review & editing. **Eileen Kaner:** Writing – review & editing. **Bernd Schulte:** Writing – review & editing.

Declarations of Competing Interest

None declared.

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Supplementary materials

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