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REVIEW ARTICLE

Are digital interventions effective in reducing suicidal ideation and self-harm? A systematic review

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ABSTRACT

Background: There is a significant lack of outcomes research examining the effectiveness of digital interventions for reducing suicidal ideation and self-harm.

Aims: To systematically review the effectiveness of digital interventions for reducing suicidal ideation and self-harm in adult populations. The possible mediating effects of depression are also discussed.

Methods: The databases Pubmed, Medline, PsycInfo, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, IEEEXplore, ACM and CRESP were searched. Only randomised controlled trials (RCTs) were included. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used. Studies were assessed for methodological quality and risk of bias using standard assessment criteria.

Results: Fourteen RCTs were reviewed, reporting data on 3455 participants. Although findings were more consistent for the effectiveness of online Cognitive Behavioural Therapy (CBT), Mindfulness-Based CBT and Dialectical Behavioural Therapy, there was insufficient research to consider any as evidence-based treatments for suicidal ideation and self-harm.

Conclusions: Digital interventions for suicidal ideation and self-harm can be a safe and acceptable option for individuals unwilling or unable to access face-to-face interventions. However, further research is needed to understand the types of interventions that could support people and the risk-benefit ratio of digital interventions for these individuals.

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Introduction

Suicide prevention and the effective support of people who self-harm are currently a major public health priority (World Health Organisation, 2017). Suicide is a leading cause of death globally, accounting for nearly a million deaths each year (Bertolote & Fleischmann, 2015).

Suicide attempts, defined as any self-injurious and/or self-poisoning act with clear suicidal intent (Logan, 2013; McLean, Maxwell, Platt, Harris, & Jepson, 2008) and self-harm, defined as any intentional, non-fatal self-injury or self-poisoning behaviour, regardless of motivation and/or degree of suicidal intent (Hawton, Zahl, & Weatherall, 2003) are closely associated with suicidal ideation, persistent self-harm behaviours and completed suicide (Witt et al., 2017).

The overall cost of self-harm to the British National Health System (NHS) alone is estimated at £162 million per annum (Tsiachristas et al., 2017). Individuals who self-harm are between 30 and 100 times more likely to die by suicide in the year following an incident of self-harm; the risk is also sustained over time, with 1 in 15 individuals dying by suicide within 9 years of an initial self-harm episode (Hawton et al., 2015). Mental health illnesses, such as anxiety and depression, are also known risk factors for self-harm. Self-harm, therefore, represents a critical mental health concern (Vieira & Lewis, 2018).

A number of effective face-to-face psychosocial interventions for self-harm and suicidal ideation are available, including Dialectical Behavioural Therapy (DBT), Cognitive Behavioural Therapy (CBT) and Problem Solving Therapy (PST) (Klonsky, May, & Saffer, 2016; Hawton et al., 2016). However, many individuals experiencing suicidal ideation or self-harm do not seek treatment, which may limit the effectiveness, impact and accessibility of these interventions (Andrews et al., 2018). Immediate help during a crisis is critical and individuals experiencing suicidal ideation or self-harm often face barriers to help-seeking, such as lack of perceived need, low suicide literacy (i.e. having little knowledge about suicidality), preference to manage problems alone, stigma, shame, fear of hospitalization, treatment costs, services' long waiting lists, limited geographical access to, or negative experiences with, health care services in the past (Zalsman et al., 2016; Hom, Stanley, & Joiner, 2015).

Following recent advances in digital technology, there has been significant growth of digital interventions as individuals can gain immediate access to evidence-based interventions before problems escalate and/or at the time of crisis (de Beurs et al., 2015; Mishara & Kerkhof, 2013). Previous reviews have found that digital interventions can be effective for a range of mental health difficulties, including depression and anxiety (e.g. Andersson, 2016; Stefanopoulou et al., 2018a, 2018b). Digital interventions, including online and

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mobile telephone applications, consist of structured sessions that aim to emulate face to face psychotherapy and improve access to care for individuals who were previously unwilling or unable to obtain these (Arnberg, Linton, Hultcrantz, Heintz, & Jonsson, 2014; Hollis et al., 2015). For example, people who experience stigma or shame may benefit from the anonymity that digital interventions can provide (Ebert et al., 2018). Moreover, digital interventions can improve the cost-efficiency of care and enable therapeutic material to be precisely tailored to individual needs (Shore, 2013).

Nevertheless, digital interventions for suicidal ideation and self-harm have received less attention. This lack of research is important given that individuals at risk of suicide or self-harm may be more likely to seek help online rather than through face-to-face consultations (Wilks, Coyle, Krek, Lungu, & Andriani, 2018). Smaller studies using a pre/post-test design have shown promising findings (e.g. Watts, et al., 2012; Williams & Andrews, 2013). However, previous reviews examining the content and usability of digital interventions and mobile apps for suicidal ideation and self-harm have shown limitations, e.g. not including enough randomised controlled trials (e.g. Lai et al., 2014; Witt et al., 2017) and not assessing risk of bias or the methodological quality of the included studies (e.g. Christensen, Batterham, & O'Dea, 2014; Larsen, Nicholas, & Christensen, 2016).

In addition, the majority of people with suicidal thoughts also meet criteria for a psychiatric disorder, most commonly depression and to a lesser extent anxiety (Nock et al., 2008). Although CBT (Butler, Chapman, Forman, & Beck, 2006), behavioural activation therapy (BA) (Ekers, Richards, & Gilbody, 2008) and PST (Malouff, Thorsteinsson, & Schutte, 2007) are common treatment approaches for depression, suicide vulnerability is often only indirectly targeted by these interventions. A recent meta-analysis found significant effects of face-to-face interventions in reducing depression but not suicidality, suggesting that they are interactive but not strictly tethered (Cuijpers et al., 2013). It is, therefore, unclear whether treatments targeting depression are also effective in reducing suicidal ideation, suicide risk or self-harm. Hence, more research is needed to delineate the specific mechanisms of change mobilised by digital interventions, along with their effectiveness.

Randomized controlled trials (RCTs) are the gold standard for evaluating the effectiveness of interventions since randomization can reduce bias and provide a rigorous tool to examine cause-effect relationships between an intervention and outcome (Hariton & Locascio, 2018). Moreover, RCTs can help to reveal mediators of therapeutic change. Conceptually, mediators identify why and how treatments have effects. Therefore, exploring the role of depression improvement in reducing suicidal ideation and/or self-harm could provide insight into key processes in achieving clinical change.

This systematic review aims to address a significant lack of outcomes research examining the effectiveness of digital interventions for reducing suicidal ideation and self-harm. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used. This review will extend previous findings (e.g. Witt et al., 2017; Larsen, Nicholas, & Christensen, 2016) by discussing (a) a range of digital interventions, including online and mobile telephone applications ("apps"), (b) the possible mediating effects of reduction in depression on suicidal ideation and self-harm, as well as (c) the risk of bias and methodological quality of existing studies in this area.

Methods

Inclusion criteria

RCTs published in peer-reviewed journals examining the effectiveness of digitally delivered psychological interventions compared with treatment as usual (TAU), active or waitlist control (WLC) conditions and/or traditional face to face interventions in reducing suicidal ideation and/or self-harm (as established by diagnostic interviews or self-report measures).

Outcome measures were (a) suicidal ideation, (b) self-harm scores and episodes of self-harm at post-treatment and follow-up, where available. Only trials reported in English were included (Figure 1).

Exclusion criteria

We excluded trials where digital interventions were used alongside face-to-face psychological therapy or which did not specifically target suicidal ideation or self-harm. Studies recruiting adolescents, children or older adults ($\leq$18 years or $\geq$65 years) were also excluded as well as case series or studies published in dissertation or abstract form or that did not report quantitative outcome data on suicidal ideation or self-harm.

Search strategy

The databases Pubmed, Medline, PsycInfo, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials as well as the IEEE Xplore, ACM and the Centre for Research Excellence of Suicide Prevention (CRESP) libraries were searched from January 2000 and up to 08 November 2018. Key term searching was undertaken. Retrieval was limited to RCTs, English language and human participants. Organic backwards (reference list search) and forward (citation search) searches were undertaken to identify additional relevant papers.

Quality ratings

Study quality was evaluated using a standard quality assessment tool (Kmet, Cook, & Lee 2004) using 14 established criteria (e.g. related to study rationale, study design, sample sizes). Quality ratings were conducted independently by two authors, HH and MT, and minor differences were settled before deciding on the final scores (maximum possible score of 1). Quality ratings for included studies are shown in Table 1.

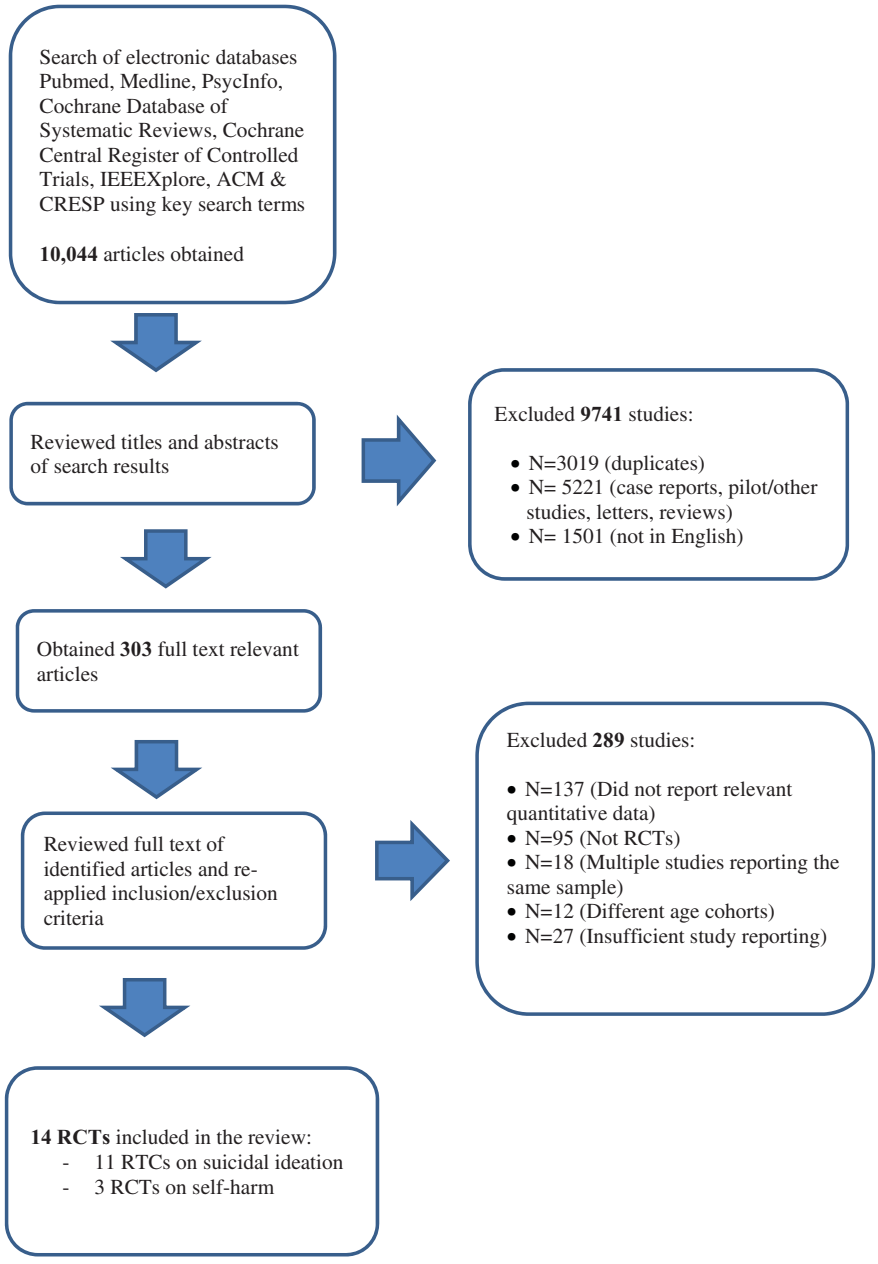

Figure 1. Flow chart of identification and selection of studies.

Risk of bias

Risk of bias was evaluated using the Cochrane Collaboration's tool for assessing risk of bias (adapted from Higgins et al., 2011) which covers: selection bias (random sequence generation and allocation concealment), performance bias (blinding of participants and personnel), detection bias (blinding of outcome assessment), attrition bias (incomplete outcome data) and reporting bias (selective reporting). Results are shown in Table 2.

Results

The literature search was conducted independently by ES, HH, and MT. Totally 10,044 potentially relevant studies were identified. After excluding duplicates, this figure reduced to 7025 records. Next, 6328 studies were excluded following a review of their titles, 394 studies following abstract review and 289 studies following full text screening, for not meeting inclusion criteria.

A total of 14 non-overlapping RCTs were, therefore, included in the review, reporting data on a total of 3,455 participants. See Table 1 for a detailed description.

No meta-analysis was conducted due to the heterogeneity of the participants in the included trials (e.g. variation in the chronicity, severity or frequency of suicidal ideation and/or self-harm episodes) and outcome measures used.

Suicidal ideation

Cognitive behavioural therapy (CBT)

Six RCTs examined the effectiveness of iCBT interventions in reducing suicidal ideation. Amongst these, four trials

Table 1. Summary of studies reviewed.

Study	N	Groups	Duration	Measures	Support	Findings	Comments	Quality ratings
Batterham et al. (2018)	194	1. Static/untailored digital intervention (10 core modules) 2. Tailored digital intervention (extra modules based on symptom profiles) 3. Attention matched control	PT: 2 weeks FU: 3 months	SIDAS	Automated email reminders	NS	FitMindKit (including behavioural activation, cognitive reframing, problem solving, exposure, motivational interviewing, mindfulness, relaxation) Interactive, attention-matched, online placebo control program ('Healthwatch')	0.75
Christensen et al. (2013)	155	1. I-CBT only 2. Weekly calls only 3. I-CBT plus weekly calls 4. TAU	PT: 6 weeks FU: 6 & 12 months	GHQ-28	Unguided (Mood Gym for depression in weeks 2–6)	NS	iCBT for depression Participants had moderate to high levels of psychological distress at entry point	0.85
Christensen et al. (2016)	1149	1. I-CBT 2. Attention-matched, online control program	PT: 6 weeks FU: 6 months	PSF	Unguided	i-CBT < control at PT only	i-CBT for insomnia ('SHUTi') Interactive, attention-matched, online placebo control program ('Healthwatch')	0.92
Franklin et al. (2016) (3 RCTs)								
	114	1. I-TEC 2. Control version of i-TEC	PT: 4 weeks FU: 1 month	SITBI	Unguided	Suicide plans: I-TEC < Control at PT and FU. Self-cutting episodes & NSSI behaviours: I-TEC < Control at PT	Individuals with a recent history of frequent NSSI	0.78
	131	1. I-TEC 2. Control version of i-TEC	PT: 4 weeks FU: 1 month	SITBI	Unguided	Self-cutting episodes: I-TEC < Control at PT only		0.78
	163	1. I-TEC 2. Control version of i-TEC	PT: 4 weeks FU: 2 month	SITBI	Unguided	Suicide plans, NSSI episodes, NSSI events, Self-cutting episodes & self-cutting events: I-TEC < Control at PT only		0.78
Guille et al. (2015)	199	1. I-CBT 2. Information only (attention control) group (participants received 4 emails with general information as active control)	PT: 4 weeks FU: 12 months	PHQ-9 (item 9)	Email reminders at 2, 5, 8 & 11 months to review sessions	ICBT < Active control	i-CBT for depression 'Mood Gym' (4 sessions) as prevention programme for medical students	0.75
Handley et al. (2013)	304	1. Single CBT sessions (depression-focused or alcohol-focused) 2. Face to face CBT (integrated) 3. I- CBT (integrated) 4. Counselling (as control condition)	PT: 10 weeks FU: 12 months	BDI-II	Brief therapist contact following each computer-integrated CBT session	NS	Combined data from 2 RCTs	0.75
Moritz et al. (2012)	210	1. I-CBT 2. WLC	PT: 8-weeks	SBQ-R	Unguided	NS	i-CBT for depression ('Deprexis') (incl behavioral activation, cognitive restructuring, mindfulness/acceptance and social skills training)	0.85

(*continued*)

Table 1. Continued.

Study	N	Groups	Duration	Measures	Support	Findings	Comments	Quality ratings
Tighe et al. (2017)	61	1. I-ACT 2. WLC	PT: 6 weeks	DSI-SS	Unguided	NS	Mobile app for suicidal ideation, depression, psychological distress and impulsivity ('ibobbly')	0.77
Van Spijker et al. (2014)	236	1. I-CBT/DBT/PST/MBCT 2. WLC	PT: 6 weeks FU: 2, 4 & 6 weeks	BSS	Unguided	Treatment < WLC at PT and FU	ICBT/DBT/PST/MBCT intervention for suicidal ideation Participants with a history of repeated suicide attempts did better	0.78
Van Spijker et al. (2018)	418	1. ICBT/DBT 2. Attention matched control ('Living Well' Healthy lifestyle course)	PT: 6 weeks FU: 6 & 12 months	C-SSRS SIDAS	Unguided	NS	ICBT/DBT intervention for suicidal thinking ICBT/DBT intervention was more effective for participants who had spent fewer months thinking about suicide	0.92
Wagner et al. (2014)	62	1. FTF CBT 2. I-CBT	PT: 8 weeks FU: 3 months	BSI	Guided	NS	i-CBT for depression (intense therapist support)	0.77
Wilks et al. (2018)	59	1. iDBT 2. WLC	PT: 8 weeks FU: 3 & 4 months	SSI	Unguided	NS	iDBT for suicidal individuals who engage in heavy episodic drinking. Daily emails and/or text messaging as reminders	0.77

BA: Behavioural activation therapy; CBT: Cognitive behavioural therapy; DBT: Dialectical behavioural therapy; ACT: acceptance and commitment therapy; MBCBT: mindfulness-based cognitive behavioural therapy; PST: problem-solving therapy; TEC: therapeutic evaluative conditioning; NSSI: Non-suicidal self-injury; FTF: Face to Face; WLC: Waitlist control; FU: Follow up; PT: Post-treatment; NS: non-significant; GHQ-28: General Health Questionnaire (28 items); BSI: Brief Symptom Inventory; BDI-II: Beck Depression Inventory II; RCT: Randomised Controlled Trial; C-SSRS: Columbia-Suicide Severity Rating Scale; SIDAS: Suicidal Ideation Attributes Scale; PHQ-9: Patient Health Questionnaire; SITBI: Self-Injurious Thoughts and Behaviors Interview; DSI-SS: Depressive Symptom Inventory Suicidality Subscale; BSS: Beck Scale for Suicide Ideation; SBQ-R: Suicidal Behaviors Questionnaire-Revised; PSF: Psychiatric Symptom Frequency scale.

Table 2. Risk of bias assessments for included studies.

Study	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Batterham et al. (2018)	+	?	–	-	-	+
Christensen et al. (2013)	+	+	–	–	–	+
Christensen et al. (2016)	+	+	–	–	+	+
Guille et al. (2015)	+	+	–	–	+	+
Handley et al. (2013)	?	–	–	–	+	+
Franklin et al. (2016) (3 RCTs)						
1.	?	-	–	-	+	+
2.	?	-	–	-	+	+
3.	?	-	–	-	+	+
Moritz et al. (2012)	+	+	–	–	+	+
Tighe et al. (2017)	+	–	–	–	+	+
Van Spijker et al. (2014)	+	+	–	–	–	+
Van Spijker et al. (2018)	+	+	–	–	–	+
Wagner et al. (2014)	+	+	–	–	-	+
Wilks et al. (2018)	+	+	–	–	+	+

+: low risk of bias; –: high risk of bias; ?: unclear risk of bias.

reported significant within-group reductions in suicidal ideation (Christensen et al., 2013; Christensen et al., 2016; Guille et al., 2015; Wagner, Horn, & Maercker, 2014) and two trials didn't (Handley et al., 2013; Moritz et al., 2012).

Three trials (Christensen et al., 2013; Christensen et al., 2016; Wagner et al., 2014) reported results on suicidal ideation and depressive symptoms, too. Specifically, Christensen et al. (2013) examined the effectiveness of iCBT for depression in reducing suicide ideation. Participants were randomised to receive iCBT plus weekly calls, iCBT only, weekly calls only or a TAU control group. Results showed that regardless of the condition, all participants experienced significant reductions in suicidal ideation whilst improvements in depression were also associated with the resolution of suicide ideation. Similarly, another trial (Christensen et al., 2016) assessed the effectiveness of an iCBT intervention in reducing both depression symptoms and suicidal ideation. Compared to a control ("Healthwatch" program) condition, iCBT significantly reduced suicidal ideation and depression symptoms at post-treatment whilst improvements in depression were maintained at follow-up. Another trial (Wagner et al., 2014) compared the effectiveness of iCBT with face to face CBT in reducing suicidal ideation. Findings showed significant suicidal ideation reductions in both groups at post-treatment, although no significant between-group differences were found. There were also reductions in depression symptoms in both groups; however, these were maintained (at follow-up) in the iCBT group only.

Another trial (Guille et al., 2015) assessed the effectiveness of iCBT program in preventing suicidal ideation amongst medical students. Findings showed that over the course of a year, there were fewer participants in the iCBT group reporting suicidal ideation than in an attention control (information only) group.

2 RCTs did not report significant improvements in suicidal ideation. Specifically, in a trial by Handley and colleagues (Handley et al., 2013) participants received single CBT sessions (either depression-focused or alcohol-focused), integrated face to face CBT, integrated iCBT or supportive counselling (as a control condition). Although suicidal ideation was associated with more severe depressive symptoms, there were no significant improvements in suicidal ideation found. Similarly, another trial (Moritz, Schilling, Hauschildt, Schröder, & Treszl, 2012) found that although participants in the iCBT group reported greater depression symptoms decline than participants in a TAU group, there were no significant reductions in suicidal ideation measures.

Other therapeutic approaches

3 RTCs examined the effectiveness of iDBT for suicidal ideation. Specifically, a trial by Wilks and colleagues (Wilks, Lungu, Ang, Matsumiya, Yin, & Linehan, 2018) assessed the effectiveness of iDBT for suicidal individuals who engage in heavy episodic drinking. Participants were allocated to either an iDBT or a WLC condition. Results showed that all participants experienced significant reductions in suicidal ideation, regardless of condition. Two trials reported results on suicidal ideation and depressive symptoms, too. A recent RCT (van Spijker et al., 2018) examined the effectiveness of an online intervention using both CBT and DBT components, compared with an attention matched, control condition (a "Healthy Lifestyle" course). Although there were reductions in both suicidal ideation and depression measures across groups, no significant group differences were found. However, the trial was underpowered and, given its high attrition rate, any smaller differences may have not been detected. Another RCT (van Spijker et al., 2014) examined the effectiveness of an online intervention based on CBT, DBT, PST and Mindfulness Based Cognitive Therapy (MBCT) in reducing suicidal ideation. Compared to a WLC condition, participants in the intervention group showed significant improvements in suicidal ideation; this effect was also more pronounced in participants with a history of repeated suicide attempts. Depressive symptoms also showed small but non-significant improvements.

One RTC (Tighe et al., 2017) examined the effectiveness of online Acceptance and Commitment Therapy (i-ACT) in reducing suicidal ideation and depression symptoms. Compared to a waitlist control condition, participants in the iACT group showed significant reductions in depression and psychological distress symptoms, but not suicidal

ideation, at the end of the intervention. Nevertheless, not all participants had suicidal ideation at baseline and the trial may have been under-powered to find significant effects.

Franklin and colleagues (Franklin et al., 2016) examined the effectiveness of a brief Therapeutic Evaluative Conditioning (TEC) intervention compared to a control TEC condition for suicidal ideation; no significant between group differences were found at post-treatment and follow-up.

Finally, a different RCT (Batterham, Calear, Farrer, McCallum, & Cheng, 2018) examined the effectiveness of a transdiagnostic, tailored online intervention combining different therapeutic components (e.g. behavioural activation, cognitive reframing, problem solving, exposure, motivational interviewing, mindfulness, relaxation) compared to an untailored version of this programme and an interactive, attention-matched, online placebo control program. Findings showed no significant effects of treatment on suicidal ideation or depression symptoms at post-treatment and 3 months follow-up.

Self-harm

Franklin et al. (2016) reported findings from 3 different RCTs; in their first trial they found that, compared to a control condition, the i-TEC group showed significant reductions in self-cutting episodes (i.e. discrete time periods of self-cutting behaviours), overall non-suicidal self-injury (NSSI) episodes (including self-cutting behaviours) and suicide plans at post-treatment. Only reductions in suicide plans remained significant at 1 month follow-up (RCT 1). In two other trials, they found that compared to a control condition, the i-TEC group showed significant reductions in self-cutting episodes (RCT 2 and 3) as well as self-cutting events (i.e. instances of actual or attempted tissue damage during an episode), overall NSSI episodes, overall NSSI events and suicidal plans (RCT 3) at post-treatment only.

Discussion

This systematic review evaluated the effectiveness of digital interventions, including online and mobile telephone applications, in reducing suicidal ideation and self-harm in adult populations. A total of 14 RCTs met the inclusion criteria, accounting for 3455 participants.

The majority of the interventions focused on suicidal ideation as the main outcome, whereas 3 trials focused on self-harm (Franklin et al., 2016). Half of the RCTs (50%) included in this review used psychosocial interventions targeting depression (Moritz et al., 2012; Christensen et al., 2013, 2016; Wagner et al., 2014; Handley et al., 2013; Batterham et al., 2018; Wilks et al., 2018), rather than suicidal ideation or self-harm only (Franklin et al., 2016; van Spijker et al., 2014, 2018; Tighe et al., 2017). One RCT examined the effectiveness of an online intervention for depression in the prevention of suicidal ideation (Guille et al., 2015). 10 RCTs (71%) reported findings from online interventions (Christensen et al., 2016, 2013; Moritz et al., 2012; Wagner et al., 2014; Handley et al., 2013; Batterham et al., 2018; van Spijker et al., 2018; Wilks et al., 2018; Guille et al., 2015; van Spijker et al., 2014) and four RCTs reported findings from mobile apps (Franklin et al., 2016; Tighe et al., 2017).

We found no consistent effectiveness of digital interventions for suicidal ideation and/or self-harm compared with face-to-face interventions, TAU, active or waitlist control conditions. Three RCTs demonstrated significant treatment effects on suicidal ideation (Guille et al., 2015; van Spijker et al., 2014; Christensen et al., 2016) with additional improvements on depression (Christensen et al., 2016) and worry (van Spijker et al., 2014; consistent with the intervention's focus on repetitive thinking in relation to suicidal thoughts) as possible mediating mechanisms. On the other hand, some studies found significant effects of digital interventions on depressive symptoms but not suicidality (Moritz et al., 2012; Tighe et al., 2017). Given the relatively small number of studies included in this review, our findings provide limited evidence so far that digital interventions for depression may be effective in reducing suicidality, consistent with previous findings that depression and suicidality may not be entirely tethered and have different trajectories (Cuijpers et al., 2013; Christensen et al., 2013; Batterham et al., 2018). Although associations between worry and rumination and the repetitive character of suicidal thoughts have previously been described (e.g. Kerkhof & van Spijker, 2011; Morrison & O'Connor, 2008) there is currently not sufficient support for this using digital interventions. More research is, therefore, needed to determine the effectiveness of digital interventions targeting suicidal ideation and the possible mediating effects of depression and worry on treatment outcomes.

Face to face interventions using CBT, DBT, PST and Mindfulness have been consistently shown to be effective in reducing suicidal ideation and self-harm in adult populations (e.g. Tarrier, Taylor, & Gooding, 2008; Linehan et al., 2006; Townsend et al., 2001; Mark, Williams, & Swales, 2004; Segal & Williams, 2002). Such findings appear to be consistent with the use of i-CBT (Guille et al., 2015) and i-CBT, i-DBT, i-PST and Mindfulness-based i-CBT (i-MBCBT) (van Spijker et al., 2014) in this review, although the level of evidence is less robust in view of the lack of more controlled studies reporting positive findings. It may also be worth noting that two RCTs reporting positive effects recruited primarily adults with minimal or no past history of suicidal ideation (Guille et al., 2015) or less severe suicidal ideation (van Spijker et al., 2014), suggesting that digital interventions may be more beneficial to adults with low suicidality. This is also consistent with clinical guidelines for the use of low-intensity interventions (i.e. National Institute for Health and Care Excellence guidelines) for individuals who have low to moderate symptom levels. 3 RCTs reported significant effects of an active version of TEC on self-injurious behaviours, compared to a control version of TEC (Franklin et al., 2016). Although these findings are promising, more studies are needed to establish the effectiveness of TEC in reducing self-harm behaviours and to

provide sufficient power to examine potential mediators of treatment effectiveness.

Although 2 trials reported low attrition rates (Tighe et al., 2017; van Spijker et al., 2014), the rest of the studies included in this review reported much higher attrition rates. Individuals who dropped out of the studies often had more severe levels of depression and suicidal behaviours (e.g. van Spijker et al., 2018), indicating that severe symptoms may interfere with completion of such interventions (Christensen, Griffiths, & Farrer, 2009); however, future research is needed in order to explore this hypothesis further. Moreover, only two RCTs demonstrated sustained positive benefits on suicidal ideation (12 months (Guille et al., 2015); 12 weeks (van Spijker et al., 2014) at follow-up; therefore, longer-term studies are crucial.

Overall, this systematic review found limited evidence that digital interventions for suicidal ideation and self-harm are harmful and supports that they may be beneficial to adults with less severe suicidal ideation. Future research should, however, investigate further which individuals might benefit most from digital interventions targeting suicidal ideation and self-harm and what adjustments might need to be made to the programs in order to accommodate for various degrees of suicidality and self-harm. For example, interventions specifically targeting suicidal ideation and/or self-harm and tailoring these to best address individual needs might help improve outcomes regardless of symptom severity.

Methodological quality of studies

Many participants dropped out in the examined studies and data were not always analysed on an intention-to-treat basis. This may have introduced bias, over- or under-estimating the benefits of examined interventions. Only some of the studies reported treatment adherence rates, of which some studies indicated that adherence was positively associated with better outcomes (e.g. van Spijker et al., 2018). Whether adherence to the treatment sessions was affected by depression, worry/anxiety or other distress symptoms was not always reported; similarly, not all studies reported adverse life events and reasons for dropouts. Finally, since the control groups usually consisted of usual care, researchers and participants were not blinded to the interventions, possibly introducing bias. Future studies should ensure rigorous methodology and reporting, including adequate randomization, allocation concealment, intention-to-treat analysis, and blinding of at least outcome assessors. Future studies would also benefit from examining outcomes in terms of the chronicity, frequency and severity of symptoms associated with suicidal ideation and self-harm. In addition, clear descriptions of the interventions should be provided together with a description of expertise of the instructors, when offered in guided or semi-guided formats. Although there was heterogeneity of the included interventions it is likely that different interventions share common techniques or mechanisms. Therefore, to support understanding of why interventions may, or may not, work it is necessary to examine the effectiveness not only of the interventions but also of the components within interventions that may influence treatment outcomes. This would help to support the optimal design of future interventions.

Other considerations

Treatment dropout tends to be relatively high for online interventions (Melville, Casey, & Kavanagh, 2010) so the dropout rates in this review were predictable. However, many RCTs were not powered enough to detect significant between-group differences in suicide ideation and self-harm outcome measures.

We also excluded pseudo-RCT (non-randomised controlled trials) and observational pre-test/post-test design studies but reviews were recently conducted in this area (Witt et al., 2017). Few RCTs included long-term follow-ups, thus findings remain unclear in terms of the longer effects of the examined interventions for suicidal ideation and self-harm. Moreover, not all trials controlled for non-specific effects of treatment; such effects cannot, therefore, be ruled out.

Many included studies used an active control as comparison group. There is evidence that spontaneous remission and improvement over time in such groups are greater than waitlist controls (e.g. Patterson, Boyle, Kivlenieks, & Van Ameringen, 2016), which may have affected outcomes of individual studies and made the evaluation of longer-term group differences more difficult.

A potential limitation of this review may be that we included interventions ranging from 2 weeks to 8 weeks in duration. It, therefore, remains unclear what the best duration of support might be to achieve optimal treatment outcomes. Finally, it may be worth noting that digital interventions discussed in this review are differentiated from other technology delivered interventions, such as the use of brief, periodic texts to deliver caring messages for suicide prevention (e.g. Comtois et al., 2019) and future research should delineate the effectiveness of these interventions for suicidal ideation and self-harm further.

Recommendations for future interventions

In summary, this systematic review has found limited evidence for the effectiveness of digital interventions for suicidal ideation and self-harm in adult populations. Findings were more consistent for the effectiveness of i-CBT, i-MBCBT and i-DBT, although there is still insufficient research to consider any as evidence-based treatments in this area.

Overall, this review supports that digital interventions for suicidal ideation and self-harm can be a safe and acceptable option for individuals who are unwilling or unable to access face-to-face interventions. However, further research is needed to better understand the types of interventions that could support people experiencing suicide ideation and self-harm as well as the risk-benefit ratio of digital interventions for these individuals.

Disclosure statement

On behalf of all authors, the corresponding author states that there is no conflict of interest, On behalf of all authors, the corresponding author also confirms that our manuscript is a systematic review and that all researchers have followed the PRISMA guidance. The review protocol has not been published on Prospero.

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