Can Acceptance, Mindfulness, and Self-Compassion Be Learned by Smartphone Apps? A Systematic and Meta-Analytic Review of Randomized Controlled Trials

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The potential health benefits of acceptance, mindfulness, and self-compassion are well-documented. However, interventions that teach these principles typically rely on face-to-face delivery, which can limit their dissemination. Delivering these interventions through smartphone apps could help overcome this. This meta-analysis examined whether principles of acceptance, mindfulness, and self-compassion can be learned through smartphone apps. Twenty-seven randomized controlled trials were included. Smartphone apps that included acceptance and/or mindfulness components resulted in significantly higher levels of acceptance/mindfulness than comparison conditions (k=33; g=0.29; 95% CI=0.17, 0.41). These effects were moderated by the type of comparison and whether reminders to engage were offered. Smartphone apps also resulted in significantly lower levels of psychological distress than comparisons (k=22; g=−0.32; 95% CI=−0.48, −0.16). Meta-regression revealed a negative relationship between the effect sizes for mindfulness/acceptance and the effect sizes for distress. Smartphone apps produced significantly greater increases in self-compassion than comparisons (k=9; g=0.31; 95% CI=0.07, 0.56), although the quality of RCTs in this analysis was poor. Findings suggest that principles of acceptance, mindfulness, and self-compassion may be learned through cheap, easily accessible, and low-intensity interventions delivered via smartphone apps. However, the quality of available evidence is poor, as low risk of bias was noted in few trials (18%) and the observed effects were likely explained by a digital placebo.

Keywords: smartphone apps; acceptance; mindfulness; RCT; meta-analysis

Acceptance- and mindfulness-based interventions are becoming increasingly popular treatments for numerous psychological and somatic conditions. These interventions, grounded in principles of nonjudgmental awareness, acceptance, defusion, and self-compassion, aim to address an individual’s relationship with, and response to, certain cognitive and affective processes, rather than directly trying to modify them or their content (Hayes, Villatte, Levin, & Hildebrandt, 2011; Hofmann & Asmundson, 2008). Importantly, several previous meta-analyses of randomized controlled trials (RCT) have documented the efficacy of acceptance- and mindfulness-based interventions delivered in either face-to-face or online formats for several mental health problems, including symptoms of depression (Hofmann, Sawyer, Witt, & Oh, 2010), anxiety (Vollestad, Nielsen, & Nielsen, 2012), eating disorders (Linardon, Fairburn, Fitzsimmons-Craft, Wilfley, & Brennan, 2017; Linardon, Gleeson, Yap, Murphy, & Brennan, 2018), psychosis (Louise, Fitzpatrick, Strauss, Rossell, & Thomas, 2018), and general distress (Spijkerman, Pots, & Bohlmeijer, 2016).

Mindfulness and acceptance are closely related constructs. Mindfulness involves deliberately paying attention, nonjudgmentally, to present-moment experiences, usually cultivated through exercises such as meditation or body scans (Kabat-Zinn, 2003). Acceptance, which is a component of
mindfulness (Bishop et al., 2004), involves experiencing events fully, as they are, and without defence (Hayes, 2004). Acceptance can be acquired through techniques that increase psychological flexibility and reduce experiential avoidance (Hayes, 2004). Being more mindful and accepting of certain experiences is said to enable people to let go of any habitual or harmful responses to these experiences and instead select healthier or more adaptive ways of responding (Bishop et al., 2004).

A growing body of literature has provided evidence for the possible mental health benefits of mindfulness- and acceptance-based skills. For example, learning and applying mindfulness and acceptance strategies in experimental studies has been causally linked with reductions in anxiety symptoms (Wahl, Huelle, Zurowski, & Kordon, 2013), body dissatisfaction and negative affect (Atkinson & Wade, 2012), and general distress (Cassin & Rector, 2011). More importantly, accumulating evidence indicates that the efficacy of acceptance- and mindfulness-based interventions on mental health problems is mediated or explained by increases in acceptance and mindfulness (Gu, Strauss, Bond, & Cavanagh, 2015), suggesting that these skills could be the crucial mechanisms underlying these interventions’ therapeutic effects on psychological outcomes. Taken together, available evidence indicates that learning acceptance and mindfulness skills could be important for improving mental health and well-being.

One important principle of acceptance- and mindfulness-based interventions is self-compassion. Self-compassion, which involves developing a caring, accepting, and reassuring relationship with oneself (Neff, 2003a), has been statistically, temporally, and causally connected to a range of beneficial mental health outcomes (Kirby, Tellegen, & Steindl, 2017; Zessin, Dickhäuser, & Garbade, 2015), and may also mediate symptom improvement during acceptance- and mindfulness-based interventions (Keng, Smoski, Robins, Ekblad, & Brantley, 2012). Self-compassion and mindfulness are related, in that both highlight the importance of taking a nonjudgmental stance towards the self (Barnard & Curry, 2011). However, self-compassion extends beyond mindfulness, as it also involves connecting with others (rather than isolating oneself), adopting an attitude of kindness, and understanding the universality of suffering in the human experience (Neff, 2003b). Although compassion-focused interventions differ from acceptance- and mindfulness-based interventions in many important ways (see Kirby & Gilbert, 2019), each approach also shares some common features, such as encouraging a more aware, kind, accepting, and nonjudgmental relationship with the self (Hayes et al., 2011). It is thus not surprising that improvements in self-compassion are consistently observed during acceptance- or mindfulness-based interventions (e.g., Falsafi, 2016; Koszycki et al., 2016; Yadavaia, Hayes, & Vilardaga, 2014), even though many of these interventions may not be designed to specifically cultivate self-compassion.

Although the benefits of learning mindfulness, acceptance, and self-compassion are well-known (Gu et al., 2015), most interventions that teach these principles rely on face-to-face delivery, which can limit their dissemination (Cavanagh, Strauss, Forder, & Jones, 2014). For example, barriers such as cost, therapist availability, anonymity concerns, and geographic location can prevent people from seeking out or accessing these interventions (Kazdin, 2018). Thus, translating these interventions for delivery via digital technology, and in particular smartphone “apps,” holds enormous promise in overcoming these barriers and reducing the existing treatment gap (Fairburn & Patel, 2017).

Interventions delivered via smartphone devices hold many advantages over other technology-delivered interventions (e.g., computers). For example, most people keep their smartphone switched on at all times, within arm’s reach, and take it with them wherever they go, meaning that there is a greater opportunity to broaden the reach of evidence-based interventions into the daily lives of end-users (Bakker, Kazantzis, Rickwood, & Rickard, 2016). Moreover, interventions delivered via smartphones allow users to engage in exercises and monitor symptoms in their natural environment, in real-time, and immediately before, during, and after crucial events (Heron & Smyth, 2010). Finally, people are more able to use their smartphone in private and at a time and place of choice, which may not be possible with desktop computers (Stolz et al., 2018).

Given that learning acceptance, mindfulness, and self-compassion has been temporally linked with mental health and well-being improvements (Gu et al., 2015), it would be valuable to know whether inexpensive and easily accessible smartphone apps can effectively teach these principles, as this could have important implications for models of mental health care delivery (e.g., apps could be embedded within the stepped-care approach to mental health treatment; Kazdin, 2017). Although meta-analyses have documented the efficacy of mindfulness- and acceptance-based smartphone apps in reducing mental health problems, with the strongest effects observed in trials that offer therapist guidance and reminders to engage in the app (Firth et al., 2017a, 2017b; Linardon, Cuijpers, Carlbring, Messer, & Fuller-Tyszkiewicz, 2019), no meta-analysis to date has examined whether mindfulness, acceptance, and self-compassion principles can be learned...
through these smartphone apps. In this context, whether these principles can be “learned” has been operationalized as an increase in scores on self-report questionnaires that assess these particular constructs (see Cavanagh et al., 2014).

Thus, the present meta-analysis of RCTs had three aims: (a) to examine whether acceptance- and mindfulness-based interventions delivered via smartphone apps can effectively enhance mindful awareness, present-moment acceptance, and self-compassion; (b) to test whether these effects are moderated by certain trial characteristics (i.e., use of professional support or reminders to engage, target sample, and comparison group type); and (c) to examine the relationship between changes in mindfulness and acceptance with changes in psychological distress. The final aim was examined via a meta-regression, in which the effect size for changes in mindfulness/acceptance was set as the independent variable and the effect size for changes in psychological distress was set as the dependent variable.

Method
Search Strategy and Study Selection
Three major online databases (PsycINFO, Medline, and Cochrane database of randomized controlled trials) were searched in December 2018 (and updated in March 2019) using the following search terms: smartphone* OR “mobile phone” OR “cell phone” OR “mobile app” OR phone OR android OR m-health OR m-health OR “cellular phone” OR “mobile device” OR mobile-based OR “mobile health” OR tablet-based AND random* OR trial* OR allocat* AND mindful* OR accept* OR ACT OR meditate* OR compass*. Reference lists of relevant reviews and the included studies were also hand searched to identify any further eligible studies.

Studies were included if (a) it was an RCT that (b) delivered an app-based smartphone intervention, (c) that contained mindfulness, acceptance, or compassion-focused strategies, (d) compared with either an inactive or active comparison group, (e) and included an outcome measure of acceptance, mindfulness, or self-compassion. Criterion C was determined based on the trial authors’ description of their smartphone intervention; that is, if, in their description, there was any mention that the smartphone app contained mindfulness, acceptance, or compassion-focused strategies or exercises, then this trial was deemed eligible for inclusion. Both published and unpublished trials were eligible for inclusion. Unpublished trials (dissertations) were accessed through the three online databases mentioned above. Trials of interventions delivered solely in part via smartphone apps were included. No restrictions on the sample were applied. Inactive comparisons were defined as wait-list controls or assessment-only conditions. Active comparisons were defined as those controlling for the time and attention given to participants allocated to the smartphone app (e.g., informational resources, gaming apps), or an intervention that did not contain any acceptance, mindfulness, or compassion-focused strategies. Studies were excluded if (a) there was no relevant comparison group (e.g., a two-arm trial comparing two mindfulness apps was excluded), (b) computerized interventions or text message–only interventions were delivered, or (c) if an effect size could not be calculated. If a study did not include data for effect size calculation, the authors were contacted, and the study was excluded if they failed to provide the data.

Quality Assessment and Data Extraction
Trial quality was assessed using four criteria from the Cochrane Risk of Bias tool (Higgins & Green, 2011). The following four domains of bias were assessed: adequate generation of allocation sequence (i.e., assigning participants to conditions on the basis of a chance process); concealment of allocation to conditions (i.e., ensuring those involved in the study do not know the next assignment); blinding of outcome assessors (i.e., ensuring those who assess outcomes via interviews are not aware of the condition the participant was assigned to) or the use of self-report questionnaires (because self-report questionnaires do not require direct interaction with an assessor); and dealing with incomplete outcome data (assessed as low risk when all randomized participants were included in the analyses). For each of the four domains, a rating of low risk, high risk, or unclear was made for each trial. A low risk of bias trial was considered to be those where all four domains received a low risk rating. The study author conducted the quality assessments and an independent research assistant coded a random 30% of trials to check for accuracy. Excellent agreement was observed between the two coders (87%, 87%, 100%, and 100% agreement across the four respective domains). Only minor disagreements were observed, which were resolved through consensus. Characteristics related to the participants, intervention, comparison groups, outcome measures, and post-assessment length were also extracted from the included trials.

Meta-Analytic Procedure
For each comparison between a smartphone app and a comparison condition, the effect size was calculated by dividing the difference between the two group means by the pooled standard deviation at posttest. The standardized mean difference was converted to
Hedges’s $g$ to correct for small sample bias (Hedges & Olkin, 1985). Effect sizes were calculated using conversion equations from significance tests if means and standard deviations were not reported (Borenstein, Hedges, Higgins, & Rothstein, 2009). To calculate a pooled effect size, each study’s effect size was weighted by its inverse variance. If data from both intention-to-treat and completer analyses were presented, the former was extracted and analyzed. If a study reported both a measure of mindfulness and acceptance, then the mindfulness measure was chosen because it is considered a meta-construct that encompasses acceptance (Cavanagh et al., 2014). But if a study reported multiple measures of mindfulness (or multiple measures of acceptance), then the mean of the effect sizes from each measure within the study was calculated before the effect sizes were pooled. Self-compassion measures were analysed in separate meta-analyses to the mindfulness and acceptance measures.

Comprehensive Meta-Analysis Version 3.0 was used for the analyses (Borenstein et al., 2009). Since considerable heterogeneity was expected among the studies, random effects models were used. Heterogeneity was examined by calculating the $I^2$ statistic, which quantifies heterogeneity revealed by the Q-statistic and reports how much overall variance (0–100%) is attributed to between-study variance (Higgins & Thompson, 2002). Subgroup analyses were conducted to explore sources of heterogeneity under a mixed effects model, which pools studies within a subgroup using a random effects model, but tests for significant differences between subgroups using fixed effects models (Borenstein et al., 2009). Univariate meta-regressions were also performed to examine whether there was a relationship between two continuous variables, as indicated by a regression slope and an associated $p$-value. Publication bias was examined through the trim-and-fill procedure (Duval & Tweedie, 2000) and Begg and Mazumdar’s rank correlation test. The latter test assumes that trials with larger sample sizes are published more often and that studies with an equal sample size are published less often when the effect size is smaller. Thus, a negative correlation between the effect sizes and their standard errors indicates possible publication bias. Statistically significant correlations (one-tail) are indicative of possible publication bias (Cuijpers, Smit, Bohlmeijer, Hol- lon, & Andersson, 2010).

**Results**

A flowchart of the literature search is presented in Figure 1. Twenty-seven RCTs, with 31 app-supported smartphone intervention conditions, met full inclusion criteria. Most trials delivered an app that was entirely based on mindfulness and acceptance interventions, and one trial delivered an app that was entirely based on compassion-focused principles. The other trials ($k = 7$) delivered multi-component apps (i.e., contained some components of acceptance, mindfulness, or compassion among other components from different intervention approaches like cognitive or behavior therapy). The target samples varied, and included either the general population, university students, people with preexisting mental health problems (e.g., elevated levels of depression, anxiety, stress, etc.), adult smokers, women with chronic pain, or women with breast cancer.

The measures of mindfulness used as outcomes were the Five Facet Mindfulness Scale (FFMS; Baer et al., 2008), Cognitive and Affective Mindfulness Scale-Revised (CAM-S-R; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007), Mindful Attention and Awareness Scale (MAAS; Brown & Ryan, 2003), and the Philadelphia Mindfulness Scale (Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008). The measures of acceptance used as outcomes were the Acceptance and Action Questionnaire (AAQ; Bond et al., 2011), the Acceptance Subscale from the Emotion Regulation Skills Questionnaire (ERSQ-A; Berking & Znoj, 2008), the Valuing Questionnaire (Smout, Davies, Burns, & Christie, 2014), Chronic Pain Acceptance Questionnaire (McCracken, 1998), and the Body Image Acceptance and Action Questionnaire (Sandoz, Wilson, Merwin, & Kellum, 2013). All trials that assessed self-compassion used the Self-Compassion Scale (Neff, 2003a).

The quality of included trials varied. Seventeen trials (62.9%) reported an adequate sequence generation, 5 (18.5%) reported adequate allocation concealment, 27 (100%) used self-report questionnaires (so direct interaction with an assessor was not required), and 13 studies (48.1%) reported data needed to calculate an effect size based on the intention-to-treat principle. Five trials (18.5%) met all four criteria, 4 (14.8%) met three criteria, 13 (48.1%) met two criteria, and 5 trials (18.5%) met one of the criteria. For more detail on the study characteristics, see Table 1 in the Supplementary Materials.

**Effects of Smartphone Apps on Acceptance and Mindfulness Measures**

The pooled effect size for the 33 comparisons between smartphone apps and comparison conditions on acceptance and mindfulness was $g = 0.29$ (95% CI = 0.17, 0.41), with high heterogeneity (see Figure 2). Begg and Mazumdar’s test was nonsignificant ($p = .355$). The pooled effect size remained
statistically significant when restricting the analyses to low risk of bias trials \((g = 0.40)\) and to specific measures of acceptance and mindfulness, with the exception of the AAQ.

In the previous analyses, a few trials were included in which more than one smartphone app condition was compared with the same control condition (or vice versa). These comparisons were not independent from each other, which may have artificially reduced the heterogeneity estimate and affected the pooled effect size. To deal with this, sensitivity analyses were conducted in which the comparison with the smallest effect size was only included in the analysis, and then repeated this again for the comparison with the largest effect size. These sensitivity analyses yielded a pooled effect size highly similar to the overall effect \((Table 1)\).

**Subgroup Analyses**

Subgroup analyses were conducted to test whether various study characteristics were associated with the total pooled effect size. Trials that used an inactive comparison condition (relative to an active comparison) and offered reminders to engage in the app (relative to trials that did not offer reminders) produced significantly stronger effect sizes. Target population, the use of professional support, or intervention program were not significantly associated with the pooled effect size.\(^1\)

**Effects of Smartphone Apps on Self-Compassion**

The pooled effect size for the nine comparisons between smartphone apps and comparison conditions on self-compassion was \(g = 0.31\) \((95\% \text{ CI} = 0.07, 0.56)\), with high heterogeneity \((I^2 = 79\%)\). See Figure 3 for a visual representation of this meta-analysis. Begg and Mazumdar’s test was nonsignificant \((p = .500)\). None of the seven trials received a low risk of bias rating. When restricting the analyses to trials that delivered a wait-list control \((k = 5)\), the pooled effect size was \(g = 0.53\) \((95\% \text{ CI} = 0.36, 0.70)\). When only one comparison per study was included in the meta-analysis (the smallest effect size), the effect size was a nonsignificant \((p = .091)\) \(g = 0.29\) \((95\% \text{ CI} = -0.04, 0.62)\). A significant pooled effect size of \(g = 0.40\) \((95\% \text{ CI} = 0.13, 0.66)\) was observed when the

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\(^1\) All analyses including subgroup analyses were run again without the trials that used the AAQ as a measure of acceptance to see if the pattern of results changed (given that these trials produced a negative effect size). The pattern of results remained almost identical, except that therapist guidance produced significantly larger effects than no therapist guidance. Readers can refer to Supplementary Table 2 for these data.
comparison with the largest effect size was included. Subgroup analyses were not performed given the small number of trials.

**Effects of Smartphone Apps on Depression and Distress**

A meta-analysis was also conducted to test whether smartphone apps outperformed comparison conditions on measures of depression or distress. Twelve trials reported a measure of depression and two trials reported a measure of psychological distress. For the purpose of this meta-analysis, the two psychological distress measures (i.e., the Kessler Psychological Distress Scale and the total score from the Depression Anxiety Stress Scale) were combined with the depression measures to estimate a pooled effect.

The pooled effect size for the 22 comparisons between smartphone apps and control conditions was $g = -0.32$ (95% CI = $-0.48, -0.16$), in favor of smartphone apps. There was high heterogeneity ($I^2 = 75\%$). The pooled effect sizes remained statistically significant after adjusting for possible publication bias ($g = -0.40$; 95% CI = $-0.55, -0.24$) and when restricting the analyses to (a) low risk of bias studies ($g = -0.45$; 95% CI = $-0.74, -0.16$), (b) one comparison per study with

<table>
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<th>Upper limit</th>
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the smallest effect size \( g = -0.37; 95\% \text{ CI} = -0.56, -0.17 \), and (c) control groups that were inactive \( g = -0.45; 95\% \text{ CI} = -0.61, -0.28 \). A nonsignificant effect size \( p = .132 \) was observed when active comparison groups were used \( g = -0.20; 95\% \text{ CI} = -0.46, .06 \). Removing the two trials

![FIGURE 3](image-url)
that used a measure of distress (rather than depression) produced a pooled effect size of $g = -0.33$ (95% CI = $-0.51$, $-0.15$), which was almost identical to the total pooled effect.

**META-REGRESSION**

A univariate meta-regression analysis was conducted to examine whether there was an association between changes in mindfulness/acceptance and changes in depression/distress. In this analysis, the between groups effect sizes ($g$) for changes in acceptance/mindfulness were entered as the independent variable, and the between groups effect sizes ($g$) for changes in depression/distress were entered as the dependent variable.

The meta-regression revealed a statistically significant, negative relationship between these variables (slope = $-0.48$; 95% CI = $-1.01$, 0.04; $p = .035$). After removing one possible (and seemingly extreme) outlier from this analysis (Nobis et al., 2015), a much stronger negative relationship between changes in acceptance/mindfulness and changes in depression/distress symptoms emerged (slope = $-0.97$; 95% CI = $-1.26$, $-0.69$; $p < .001$). Figure 4 presents a visual representation of this relationship. Too few studies were available to repeat this analysis with self-compassion effect sizes set as the independent variable.

**Discussion**

Accumulating research indicates that learning acceptance, mindfulness, and self-compassion skills are temporally and causally linked with mental health and well-being improvements (Gu et al., 2015; Wahl et al., 2013). However, interventions that teach these principles usually rely on face-to-face contact with a therapist, which can limit their dissemination (Kazdin, 2017). Translating these interventions for delivery via smartphone devices has the potential to overcome these issues of dissemination (Torous, Staples, & Onnela, 2015). A growing number of RCTs are beginning to examine the effects of smartphone apps that are based on principles of acceptance, mindfulness, and self-compassion. This meta-analysis thus examined whether mindfulness, acceptance, and self-compassion can be learned through these smartphone apps.

Some evidence that present-moment acceptance and mindful awarenesscan be learned through smartphone apps was found. Smartphone apps that included acceptance and/or mindfulness components resulted in significantly higher levels of acceptance and mindfulness skills ($g = 0.29$) than comparison conditions. Importantly, these effects were relatively stable after performing various sensitivity analyses (i.e., analysing low risk of bias trials only and specific target samples and measures, etc.). However, it was interesting to note that a negative effect size was observed for the AAQ (or its variants), indicating that this measure may not be as sensitive to change in app-based trials than other acceptance- or mindfulness-based measures. The magnitude of the overall improvements observed from smartphone apps was highly similar to the magnitude of improvements observed from

![FIGURE 4 Meta-Regression of the Relationship between Changes in Acceptance/Mindfulness with Changes in Psychological Distress.](image-url)
computerized interventions (Spijkerman et al., 2016), but smaller than the degree of improvements estimated in meta-analyses of therapist-delivered acceptance- and mindfulness-based interventions (Goldberg et al., 2018). Although this suggests that acceptance and mindfulness may be best learned through interventions that are led or directed by therapists, the fact that smartphone apps can also result in small increases in these principles makes them a suitable alternative for people who cannot access face-to-face interventions but who want to learn these forms of awareness. It should be noted, however, that the effect sizes were small, so greater effort is needed to further increase these forms of awareness by perhaps incorporating new, innovative, and more potent mindfulness and acceptance-based exercises within these smartphone apps.

Important moderating variables were also identified. First, studies that used an inactive comparison produced significantly larger effect sizes on acceptance/mindfulness outcomes than studies that used an active comparison. Previous meta-analyses examining the effects of smartphone-based interventions on mental health problems have reported similar findings (e.g., Firth et al., 2017), suggesting that the positive effects of smartphone apps may be a result of merely using the digital device itself, rather than the therapeutic components of the intervention. Future research is needed to quantify the extent to which this “digital placebo” may impact therapeutic outcomes in RCTs of smartphone apps (Torous & Firth, 2016). Second, studies that reminded participants to engage in the smartphone app produced significantly larger effect sizes on acceptance/mindfulness outcomes than studies that did not offer reminders. Reminders are typically implemented to facilitate user engagement in technology-based interventions (Eysenbach, 2005), and there is evidence that providing reminders does indeed increase adherence rates and user engagement (Linardon & Fuller-Tyszkiewicz, in press). That effect sizes on mindfulness/acceptance outcomes were largest in trials that implemented reminders suggests that there may be a dose-response relationship between intervention usage and increased mindfulness/acceptance skills. Testing this possible dose-response relationship experimentally is a key future direction.

Some evidence was found for an association between changes in mindfulness/acceptance with changes in mental health problems. A meta-regression revealed a negative association between the effect sizes for mindfulness/acceptance and the effect sizes for psychological distress, indicating that greater changes in these forms of awareness were associated with greater reductions in psychological distress. Critically, however, the nature of these data precludes any inference of temporal precedence, so it is unclear whether increased mindfulness/acceptance skills resulting from smartphone apps are a cause or consequence of improvements in psychological distress. Addressing this possible issue of reverse causality requires future RCTs of smartphone apps to repeatedly assess these variables throughout the course of the intervention phase, so that their trajectory of change can be tracked, and proper tests of mediation can be performed (Kazdin, 2007; Linardon, de la Piedad Garcia, & Brennan, 2016).

Smartphone apps also resulted in significantly greater improvements in self-compassion levels than comparison conditions (g = 0.31). However, this effect was small, not particularly robust in certain sensitivity analyses, and none of the trials included in this analysis received a low risk of bias rating. Consequently, current evidence for the effectiveness of acceptance- and mindfulness-based apps on increasing self-compassion is weak. Apps that are designed to specifically cultivate self-compassion and its different combinations are needed before making any firm conclusions about the effectiveness of smartphone apps on enhancing self-compassion (for a discussion, see Kirby & Gilbert, 2019).

This meta-analysis has important limitations. First, in some analyses the number of trials was relatively small. Not observing any differences between comparisons or subgroups when the number of trials is small should not be taken as conclusive evidence that meaningful differences are absent, as insufficient statistical power may have been an issue (Borenstein et al., 2009). As more RCTs are conducted in the future, so too will the ability to conduct more adequately powered analyses. Second, risk of bias was high in the majority of included trials, which may reduce the strength of the evidence. However, when limiting the analyses to trials with a low risk of bias, the outcomes were comparable to those found for all trials. Third, this meta-analysis examined only short-term effects of these apps, because most studies did not report longer-term outcomes and the studies that did report them used vastly different follow-up periods, making comparisons very difficult.

To conclude, smartphone apps that included acceptance and/or mindfulness components resulted in significant but small improvements in acceptance and mindfulness skills relative to control conditions. However, the extent to which these effects are explained by the intervention components themselves or by a “digital placebo” are yet to
be determined. Smartphone apps that contain acceptance and mindfulness components may also lead to small improvements in self-compassion, although the quality of the available evidence was poor. Present findings suggest that principles of acceptance, mindfulness, and self-compassion may be acquired through mental health smartphone apps.

**Conflict of Interest Statement**

The author declares that there are no conflicts of interest.

**Appendix A. Supplementary data**

Supplementary data to this article can be found online at https://doi.org/10.1016/j.beth.2019.10.002.

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