

A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

**EXPLORING THE MENTAL HEALTH BENEFITS OF A BRIEF APP-BASED  
LOVING-KINDNESS MEDITATION PRACTICE: A RANDOMIZED CONTROL  
TRIAL**

by

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## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

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### Abstract

Mindfulness-based interventions (MBIs) have become widely applied to improve mental health in both clinical and non-clinical populations. Loving-kindness meditation (LKM) has more recently received attention in the Western psychological and health literature (e.g., Galante et al., 2014). While LKM is sometimes included in evidence-based MBIs, recent research suggests that specific LKM interventions can have meaningful mental health benefits (Hofmann et al., 2015). There has been a surge of interest in using smartphone-based mobile applications (apps) to deliver MBIs, given the potential for reducing barriers related to cost and access (Creswell, 2017). To date, brief MBIs delivered via smartphone apps have shown promise in improving mental health in non-clinical samples (Flett et al., 2019). However, there have been no smartphone-based app studies examining the specific impacts of an app-based LKM practice on mental health outcomes. The primary aim of the present research was to determine the efficacy of a brief app-based LKM practice in improving mental health and well-being. The primary outcome was depressive symptoms and secondary outcomes were perceived stress, negative affect, positive affect, and self-compassion. A secondary aim of the study was to explore the conditions under which a brief app-based LKM may be most beneficial. To this end, the moderating roles of trait mindfulness, fear of compassion for self, and frequency of app use (dose) on intervention outcomes were examined. A two-arm randomized control trial (RCT) design was utilized. A sample of 312 undergraduate students were randomly assigned to use an app-based LKM (*Insight Timer*; intervention) or an app-based attention task (*Evernote*; control) every day for 10 consecutive days. Participants completed a standardized assessment battery pre- and post-intervention. The findings indicated that participants in the LKM condition had reductions in distress from pre- to post-intervention – namely depressive symptoms, perceived

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stress, and negative affect – compared to the control condition. There were no significant changes in positive affect and self-compassion between conditions. No significant moderation effects of trait mindfulness, fear of compassion for self, or frequency of app use emerged. Findings lend support for the use of brief app-based LKM practices to reduce distress among university students.

### **Lay Summary**

Loving-kindness meditation (LKM) has been associated with improved mental health and well-being. Recently, smartphone-based mobile applications (apps) have become a promising method to deliver health interventions. Thus, the objective of this study was to examine the mental health benefits of a brief app-based LKM practice used over 10 days. A secondary goal of the study was to explore for whom and under what conditions the LKM practice may be most beneficial. The findings revealed that participants in the LKM condition had decreases in depressive symptoms, perceived stress, and negative emotions compared to the control group. There were no significant changes in positive emotions and self-compassion. Mindfulness, fear of compassion for self, or amount of app use were not found to influence who benefited from the intervention. Findings lend support for the use of brief app-based LKM practices to reduce distress.

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## **Preface**

This dissertation is original, unpublished, independent work by the author, A. Myfanwy Ross Bakker. The Behavioural Research Ethics Board of the University of British Columbia's Okanagan Campus granted ethics approval for this research. The certificate approval numbers for the project is H19-02306.

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**Dedication**

*For my mother, Marlee, a source of inspiration, wisdom, and strength.*

*In Memory of Derek Hodge and Andrew Gruft*



## **Introduction**

Over the last three decades, interest in mindfulness has proliferated in the Western scientific community (Creswell, 2017). Derived from Buddhist and other contemplative traditions, mindfulness-based interventions (MBIs) have shown significant promise for both psychological and physical health, as well as interpersonal functioning in both clinical and non-clinical populations (Creswell, 2017; Gu et al., 2015). For example, mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT) are well-established interventions that utilize Buddhist-derived mindfulness practices taught in a secular way to improve such outcomes as stress, anxiety, and depression (Fjorback et al., 2011; Hofmann et al., 2010; Segal et al., 2002). Additionally, mindfulness practices have been integrated into broader treatment programs for psychopathology, such as dialectical behaviour therapy (DBT; Linehan, 1993) and acceptance and commitment therapy (ACT; Hayes et al., 1999).

Despite the benefits of MBIs, many people still face significant barriers in accessing mindfulness programs, such as cost, time demands, unavailability of providers, stigma, and geographical barriers (Creswell, 2017; Economides et al., 2018). As such, there is a growing interest in utilizing internet and smartphone-based mobile applications (apps) to deliver mindfulness interventions (Creswell, 2017). These interventions hold a number of advantages in that they are widely available, inexpensive, and portable. Approximately three-quarters of Canadians over the age of 18 reported owning a smartphone in 2015, and this number continues to rise (Canadian Radio-television and Telecommunications Commission, 2016). Emerging and young adults are particularly heavy users of smartphone technology (Collier, 2016). In Canada, 97 percent of 15 to 34-year-olds who were surveyed in 2016 reported owning a smartphone (Canadian Radio-television and Telecommunications Commission, 2018). As such, harnessing

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the advantages of this technology to provide mindfulness interventions seems particularly beneficial for this age group.

There has been exponential growth in the development of mindfulness apps, with a wide range of what these platforms offer – from more comprehensive training to a selection of guided practices or simple timers (Gál et al., 2021; Mani et al., 2015). A recent meta-analysis showed that despite the small number of studies, there is some initial evidence that mindfulness meditation apps may improve mental health and well-being (Gál et al., 2021). Still, there is a limited understanding of the outcomes of utilizing mindfulness based-apps for a brief period of time, which may reflect how some individuals use these programs. For example, in a study of general engagement with a freely available mindfulness app, the average number of visits to the app by users was 4.3 times (Kozlov et al., 2020). Importantly, there is emerging evidence to suggest that even brief app-based mindfulness interventions, such as using the Headspace app for 10 days, may have some mental health benefits (Flett et al., 2019). While rigorous empirical testing of specific app programs is an important area of inquiry, it is also essential to understand how the brief use of discrete types of meditation practices on these apps impacts mental health and well-being. Much of the research to date has focused on mindfulness-based meditation practices, whereas other contemplative meditations practices, such as loving-kindness meditation (LKM), have received less attention (Davidson & Dahl, 2018) and have not yet been subjected to empirical testing in a brief app-delivered format.

The overarching goal of the study was to test the efficacy of a brief, 10-day app-based LKM practice in improving mental health and well-being in a sample of university students. A sample in a university setting was selected both because of their high use of smartphone technology as well as the rates of depression and psychological distress documented in this

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population (Twenge et al., 2019). An RCT design was utilized. The primary outcome under evaluation was depressive symptoms, and secondary outcomes were perceived stress, negative affect, positive affect, and self-compassion. A secondary goal of the study was to explore the moderating roles of trait mindfulness, fear of compassion for self, and frequency of app use (dose) on intervention effects.

### **Loving-Kindness Meditation**

#### ***Defining LKM***

LKM has received increasing attention in the Western psychological and health literature (Galante et al., 2014; Shonin et al., 2015). LKM, like mindfulness meditation, is derived from ancient Buddhist and contemplative meditation practices. To date, much of the modern scientific research has been focused on mindfulness, which is typically defined as “a process of openly attending, with awareness, to one’s present moment experience” (Creswell, 2017; p. 493). While there is no universally accepted definition of mindfulness, other important elements of its conceptualization in the academic literature include a non-judgmental, accepting, or curious stance (Hofmann et al., 2011). During mindfulness meditation, attention is placed upon different present moment experiences such as breath, sensations in the body, thoughts, and sounds, in a non-judgmental and curious manner. This family of meditation practices tends to be associated with the regulation of attention and meta-awareness (Dahl et al., 2015). In traditional Buddhist practice, various forms of meditation, such as mindfulness meditation and LKM, are often practiced together and they are situated within a broader philosophical, spiritual, and ethical context (Davidson & Dahl, 2018; Hofmann et al., 2015).

LKM, also known as *metta* meditation (in Pali language), refers to an affective state in which unconditional kindness towards all beings, including oneself, is fostered (Hofmann et al.,

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2011). LKM differs from mindfulness meditation in that one's attention is focused on directing positive feelings and kind concern towards both oneself and others during meditation, rather than focused attention on one's experiences in the present moment with curiosity and non-judgment (Fredrickson et al., 2017). In Buddhism, loving-kindness is an attitudinal quality that is part of the four *brahma viharas*, or sublime states (Hofmann et al., 2011). These also include compassion (*karuna*), sympathetic joy (*mudita*; sometimes referred to as empathetic or appreciative joy), and equanimity (*upekkha*). Together, these qualities are cultivated through meditation practices to help a person achieve insight into oneself and the world, as well as to reduce suffering (Salzberg, 1995; Shonin et al., 2015). These practices are sometimes referred to as the four immeasurable meditations (FIMs; Lv et al., 2020).

Another meditation practice that is closely linked with LKM, and has also emerged in the Western psychological literature, is compassion meditation (CM; Stefan & Hofmann, 2019). CM and LKM are similar in that they are both FIMs and are considered to be relationally-oriented practices (Dahl et al., 2015). Importantly though, they are indeed two different practices (Sirotina & Shchebetenko, 2020). Where LKM is focused on cultivating kind concern and warmth towards self, others, and all beings, the focus in CM is on the awareness of suffering and a desire to alleviate that suffering in self, others, and all beings (Hofmann et al., 2011). One of the current challenges in the academic literature is that these practices and terms are sometimes used interchangeable or grouped together, which makes it difficult to disentangle their unique mechanisms and benefits (Gilbert et al., 2019). Although, as noted above, from a Buddhist perspective these meditation practices are considered to be interdependent and mutually supportive, it is important to distinguish between them to understand their unique benefits and roles in fostering mental health and well-being.

### *LKM in Practice*

While there may be some variability in terms of how LKM is practiced in different Buddhist traditions, the core psychological operation of LKM is the generation of kindness towards a variety of targets (Zeng et al., 2015). In the context of Western MBIs, such as MBSR and Mindful Self-Compassion (MSC; Neff & Germer, 2013), LKM is a form of meditation practice that is integrated as one component of many formal and informal practices taught in the eight-week programs. During a typical LKM practice, the initial target of focus for the warm and positive feelings is oneself. Subsequently, loving-kindness is progressively extended to other people or beings in a structured format. Classically, this is first toward a close friend or loved one, followed by a person who elicits neutral feelings (such as an acquaintance or stranger), then to a person with whom the practitioner has current interpersonal difficulty, and lastly to all people or beings, including oneself (Hofmann et al., 2011; The Dalai Lama, 2001). Different postures, such as lying, sitting, or standing, may be used. Short phrases are silently repeated mindfully during the LKM practice in order to direct the positive feelings to the target. For example, phrases such as “may you be safe, may you be peaceful, may you live with ease” (Kirby & Baldwin, 2018, p. 1614) are often used. These phrases are not meant to be used as a mantra, which is often repeated in a way where its meaning can become lost and is used with a different intent (Hofmann et al., 2011). Rather, they are meant to be experiential objects of attention. In this way, LKM is considered to be an affective practice (Wallace & Shapiro, 2006). Most practices used in clinical settings are closely aligned with the traditional practice, however secular language is used (Shonin et al., 2015).

### ***LKM Interventions***

To date, there has been significant variability in the length and structure of standalone LKM interventions tested in the Western psychological literature. LKM interventions typically involve weekly group sessions which can range from 10 to 120 minutes per session, and can range from four to 12 weeks in duration (Shonin et al., 2015). During most of these intervention studies, at-home practice ranging from 15 to 30 minutes, at least three times per week was recommended to participants. LKM is often integrated as part of an intervention with other meditative components, which is more similar to how it is practiced traditionally (e.g., Wallmark et al., 2013). More established empirically-supported mindfulness-based programs, such as MBSR or MSC, are typically eight weeks in duration (with accompanying home practice throughout each week), and integrate LKM as one of many mindfulness practices introduced in the program, though typically with less of a focus than other practices. As discussed above, one of the challenges in examining LKM in the context of interventions is that it is often conflated with CM and other practices.

### **Why Might LKM be Beneficial for Mental Health? A Review of Related Theories**

Given that LKM practice comes from the Buddhist tradition, much of the theory about how and why LKM offers enhances well-being, at this point, comes from the Buddhist perspective. As noted above, within the Buddhist tradition, the benefits of LKM are interwoven with other meditation practices as well as the philosophical and ethical frameworks in which they are situated (Ekman et al., 2005). From this viewpoint, LKM is a practice that helps to foster loving-kindness, which is one the four *brahma viharas* (sublime states; Hofmann et al., 2011). LKM is described an experiential practice that “employs the imagining or actual experience of the emotional state as an object of attention and mindful awareness” (Hofmann et al., 2011, p.

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1128). It is purported that practicing LKM helps to broaden attention and shift a person's relationship with themselves and others (The Dalai Lama & Cutler, 1998). By fostering this change in perspective, people are then able to relate to themselves and others more kindly, compassionately, and with unconditional love (without desire; Salzberg, 1995). Moreover, people are better able to navigate difficult emotions, such as anger and fear, by being more accepting of oneself and others. LKM is also purported to increase empathy, foster feelings of connectedness to others, enhance positive emotions, and reduce negative emotions (Salzberg, 1995; The Dalai Lama & Cutler, 1998). Importantly, LKM and other contemplative meditation practices were not traditionally developed or practiced as tools to treat psychopathology and are part of a larger spiritual practice (Davidson & Dahl, 2018), thus understanding mechanisms through which mental health benefits occur is a more recent area of scientific inquiry.

Western psychological research has begun to explore theory and mechanisms that may account for some of the observed mental health and well-being benefits of LKM practice, as well as its role in the treatment of psychopathology. However, it is not yet clear the precise role that these processes play and research is still in its infancy. One notable theory that has emerged to explain the mental health and well-being benefits of LKM is the broaden-and-build theory (Fredrickson, 1998; Fredrickson et al., 2008). According to the broaden-and-build theory (Fredrickson, 1998), enhancing positive affect can help to lessen the impact of negative affect and enable people to broaden both their thinking and attention in interpersonal and intrapersonal domains. As such, over time, experiencing frequent positive emotions help people to broaden their personal resources (cognitive, psychological, social, and physical). For example, in a study testing the broaden-and-build theory in the context of LKM, increases in positive emotions following a seven-week LKM intervention were indeed associated with reductions in depressive

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symptoms both directly and through built resources (e.g., purpose in life, increased mindfulness, social support; Fredrickson et al., 2008). Other LKM intervention studies have also garnered some support for the broaden-and-build theory (Kearney et al., 2014). Indeed, there is some support for LKM and increased positive emotions, indicating that this may be an important mechanism in LKM (Zeng et al., 2015).

A second way that LKM may offer benefit in terms of mental health is improved emotion regulation and ways of coping. A LKM intervention was found to be associated with large effects for clinician-reported changes in rumination and moderate effects for changes in adaptive emotion strategies, specifically accepting and adjusting (Hofmann et al., 2015). Rumination is an emotion regulation strategy that is both a risk and maintaining factor in depression, and tends to create cyclical depressogenic thinking patterns (Nolen-Hoeksema et al., 2008). As such, intervention approaches that mitigate this form of maladaptive emotion regulation strategy are particularly promising in reducing depressive symptoms. Another mechanism that has been proposed to account for benefits from constructive meditation practices such as LKM is cognitive reappraisal (Dahl et al., 2015). Indeed, in a study of combined attentional mindfulness and LKM, changes in cognitive distortions were found to mediate intervention effects for outcomes, including negative affect (Sears & Kraus, 2009).

While research is in its infancy, LKM does seem to shift the way in which people relate to both themselves and others. LKM is an inherently prosocial and relational practice and there is evidence to suggest that LKM is linked to feeling more connected to others (Hutcherson et al., 2008; Seppala et al., 2014), which has a host of mental health benefits (Kawachi & Berkman, 2001; Werner-Seidler et al., 2017). LKM has been shown to enhance the common humanity component of self-compassion, which reflects a perspective of shared experience (Weibel et al.,



2017). In this way, practicing LKM may foster a shift in how a person sees themselves in relation to others and help them to reframe their suffering as part of the shared human condition. LKM interventions have also been found to increase the self-kindness facet of self-compassion. In fact, enhanced self-kindness could be one of the most robust ways that LKM supports the development of increased self-compassion. Experimentally, following a brief seven-minute LKM exercise, increases in implicit positivity toward the self were observed, even after accounting for possible influences of mood (Hutcherson et al., 2008). Other authors have proposed that perspective taking (Dahl et al., 2015) and prosocial motivation (Engen & Singer, 2016) are central mechanisms of LKM.

Lastly, various neuroendocrine and neurobiological correlates are under investigation to further explore mechanisms of LKM. While a detailed discussion of these mechanisms is beyond the scope of the current study, there is some suggestion from these studies that LKM is associated with brain activation in areas that are associated with empathy and emotional processing (Dahl et al., 2015; Hofmann et al., 2011). In line with the idea that LKM may act by enhancing positive affect and prosocial motivation, other studies have demonstrated activation of regions of the brain associated with affiliative behaviours and generation of positive affect (Engen & Singer, 2016).

### **Outcome Studies of LKM**

LKM has demonstrated positive impacts on a range of indicators of mental health and well-being (Galante et al., 2014; Shonin et al., 2015; Zeng et al., 2015). What follows below is a summary of the current literature on outcomes of LKM, specifically related to depressive symptoms, stress, negative and positive affect, and self-compassion.

### *LKM and Depressive Symptoms*

Emerging evidence suggests that LKM may be an effective practice to reduce depressive symptoms (Fredrickson et al., 2008; Hofmann et al., 2015; Shahar et al., 2015). A recent review of FIM interventions found that they were effective in reducing depressive symptoms in a variety of populations and had medium effect sizes ( $d = .38$ ; Lv et al., 2020). Similarly, an earlier systematic review and meta-analysis of 22 kindness-based meditation interventions concluded that these types of practices were moderately effective in reducing depressive symptoms (Galante et al., 2014). While these reviews included a variety of other compassion and kindness-based practices, they provide robust support for further examining LKM in relation to possible mental health benefits.

More specifically, LKM interventions have been found to reduce symptoms of depression in individuals experiencing dysthymia and chronic depression (Hofmann et al., 2015). In a 12-week LKM intervention, depressive symptoms were significantly reduced at follow-up (Cohen's  $d = 3.33$ ) in a sample of people with symptoms of dysthymia. A similar 12-week LKM-based intervention in a sample of people with persistent depressive disorder was associated with reductions in both clinician-rated and self-reported depressive symptoms ( $d = 1.90$ ; Hofmann et al., 2015). While these two studies are limited by the lack of control group and small sample sizes ( $n = 10$  and  $n = 8$ , respectively), they provide some initial support for the possible utility of LKM in the reduction of depressive symptoms. LKM has also shown promise in reducing depressive symptoms in other populations. For example, in a sample of people with high self-criticism, a seven-week LKM intervention reduced depressive symptoms compared to a waitlist control condition (Shahar et al., 2015). Similarly, following a 12-week LKM intervention for

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veterans with posttraumatic stress disorder (PTSD), reductions in depressive symptoms were observed at three-month follow-up ( $d = -0.49$ ; Kearney et al., 2013).

LKM has also shown potential in reducing depressive symptoms in non-clinical samples. For example, a seven-week LKM intervention was associated with decreased depressive symptoms in sample of community adults (Fredrickson et al., 2008). More recently, in a sample of university students, a five-week LKM intervention was found to reduce depressive symptoms from baseline to six months post-intervention compared to a control condition (Totzeck et al., 2020). Interestingly, in Totzeck and colleagues' (2020) study, depressive symptoms were not reduced immediately post-intervention, which was a surprising finding that the authors suggested may have been due to the measurement point occurring during a particularly stressful period of the academic year.

In terms of brief LKM interventions, a recent study of a brief two-session LKM intervention utilized a dismantling design in an undergraduate sample to explore various meditation conditions including LKM self-focused only, LKM other-focused only, LKM both self and other-focused, and a sitting quietly control condition (Polizzi et al., 2019). Participants had two in-person guided meditation sessions and were then asked to listen to recordings or read the LKM script at home (approximately 10 minutes in length) daily over a two-week period. The mean number of days that participants reported engaging in meditation was six days. No differences in depressive symptoms were found between the treatment conditions and control condition. Importantly, the delivery of the home practice was not standardized (i.e., they either read a script and/or listened to an audio recording), and the study authors suggested that this may have impacted results.

### ***LKM and Perceived Stress***

MBIs have also been associated with reductions in stress in a variety of populations (Hoge et al., 2020) and have shown promise in reducing stress among university students (Dawson et al., 2020; Galante et al., 2018; Regehr et al., 2013; Yang et al., 2018). Recent evidence has emerged to support the potential for interventions that include LKM to reduce stress (Eriksson et al., 2018; Shonin et al., 2015). However, to date results are mixed and there is a limited amount of research in this area. A systematic review and meta-analysis of RCTs of kindness-based practices, including both LKM and CM, found mixed results for reductions in stress, though studies of stress in this review were limited to three (Galante et al., 2014). For example, in a study of an eight-week Buddhist meditation program utilizing the FIMs (i.e., loving-kindness, compassion, empathetic or appreciative joy, and equanimity), two weeks of which were focused on LKM specifically, adult community participants showed decreased perceived stress post-intervention compared to a waitlist control (Wallmark et al., 2013). More recent studies have also shown mixed findings. For example, a seven-week LKM intervention was not found to reduce stress at post-treatment compared to a control condition (Shahar et al., 2015). However, there was some indication that stress was reduced for the intervention condition at three-month follow-up. In university students, LKM was associated with decreased stress from baseline to six month follow-up, but again, not immediately post-intervention (Totzeck et al., 2020).

### ***LKM and Affect***

Findings from a systematic review demonstrated that LKM has been associated with greater positive affect and reductions in negative affect (Shonin et al., 2015). In a systematic and meta-analytic review of intervention and lab-based studies of LKM and positive emotions, LKM

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was associated with improved daily positive emotions and, when measured, gains in positive emotions post-intervention were maintained (Zeng et al., 2015). Generally speaking, both RCTs and non-RCTs included in Zeng and colleagues' review had medium effect sizes for daily positive affect and small-to-medium effects for positive affect measured immediately following LKM. That being said, findings for the impact of LKM on positive and negative affect have been somewhat mixed across the literature. These findings are reviewed below, first for induction and brief LKM interventions, followed by longer (i.e., greater than two weeks) LKM interventions for non-clinical and clinical samples.

Studies of brief LKM inductions have demonstrated changes in affect following as little as a single session. For example, a seven-minute session of LKM has been shown to increase positive affect and reduce negative affect compared to a neutral imagery induction (Hutcherson et al., 2008). Similarly, a single 20-minute LKM practice condition was associated with an increase in positive emotions compared to a more active control condition – progressive muscle relaxation (Templeton, 2007). In a sample of university students who were first-time LKM practitioners, a single 15-minute session of LKM was associated with increases in other-focused emotions (e.g., love), low arousal positive emotions (e.g., peaceful), and other positive emotions, including happiness, as well as decreases in sadness compared with a control condition (Sirotna & Shchebetenko, 2020). Conversely, in another study, a 12-minute LKM induction did not contribute to gains in explicit or implicit positive affect compared to an attention control, but led to a moderate reduction in implicit (not explicit) negative affect (Hirshberg et al., 2018). Similarly, a brief two session LKM intervention did not increase positive affect in college students (Polizzi et al., 2019). Further, greater negative affect was found for practicing a self-

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focused LKM, when compared to other meditation conditions in the study, including other-focused LKM only and LKM for both self and other.

LKM has also been associated with changes in affect both during and after longer LKM interventions in non-clinical samples. For example, LKM training has been linked to increased positive emotions day-to-day reported over time in a six-week workshop in novice meditators, however, interestingly in this study there were no reported changes in day-to-day negative affect (Fredrickson et al., 2017). In a seven-week LKM intervention, positive emotions increased over the course of the study period compared to a control condition (Fredrickson et al., 2008). Changes in affect have also been found in RCTs employing more active control conditions. In a study comparing LKM to a CM practice over five weeks, increases in positive affect were observed and were maintained by the LKM group, while the CM group had a decrease in positive affect when they completed the meditation practice (May et al., 2014). In the LKM group there was a decrease in negative affect immediately following meditation.

Lengthier LKM interventions in subclinical and clinical populations have also documented changes in affect. For example, increases in positive affect have been found following LKM interventions in those with high self-criticism (Shahar et al., 2015), dysthymia and persistent depressive disorder (Hofmann et al., 2015), and PTSD (Kearney et al., 2014). Reductions in negative affect have also been documented (Hofmann et al., 2015; Kearney et al., 2014), whereas other intervention studies have found no change in negative affect (Shahar et al., 2015). Taken together, while the evidence is mixed, there is some support for changes in both positive and negative affect following LKM inductions, brief interventions, and longer LKM interventions in both clinical and non-clinical samples.

### *LKM and Self-Compassion*

As mentioned earlier, another documented outcome of LKM is increased self-compassion (Galante et al., 2014). Self-compassion involves treating oneself in a non-judgmental and kind way when faced with difficulty or suffering (Neff, 2003b). As conceptualized by Neff (2003b), self-compassion encompasses a number of facets, including self-kindness, mindfulness, and common humanity, which together generate a self-compassionate frame of mind. Having self-compassion for oneself involves not only these positive facets, but also reduced levels of their opposing poles: self-judgment, over-identification, and isolation. While the concept of self-compassion encompasses mindfulness, it is particularly the mindful awareness of one's difficult experiences.

Self-compassion is strongly linked with improved mental health and well-being (Ferrari et al., 2019; Zessin et al., 2015). There is robust support for the protective nature of self-compassion in relation to stress, anxiety, and depression (MacBeth & Gumley, 2012). Given the benefits of self-compassion, there has been increased interest in developing interventions aimed at enhancing this characteristic. Intervention studies have demonstrated that self-compassion is a trait that is modifiable in both clinical and non-clinical samples (Wilson et al., 2019).

LKM and LKM-related practices have been linked with increases in self-compassion (Boellinghaus et al., 2014). In a systematic review and meta-analysis, kindness-based meditation practices were associated with moderate increases in self-compassion compared to passive controls (Galante et al., 2014). In a four-session LKM intervention, undergraduate students reported higher levels of self-compassion post-treatment when compared to wait-list controls (Cohen's  $d = 0.27$ ; Weibel et al., 2017). Specifically, respondents who received the LKM intervention reported greater self-kindness and common humanity. However, at eight-week

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follow-up only the self-kindness gains were maintained. Though not all studies have found significant effects. For example, in Polizzi and colleagues' (2019) two-week LKM intervention, with two in-person sessions and an average of six days of at home practice, there was no change in self-compassion compared to sitting quietly.

Similarly, LKM is linked with changes in self-compassion in sub-clinical and clinical populations. In people with high self-criticism, a seven-week LKM intervention was associated with increased self-compassion both post-treatment (Cohen's  $d = 0.73$ ) and at three-month follow-up (Cohen's  $d = 1.06$ ) compared to a wait-list condition (Shahar et al., 2015). LKM has also been associated with increases in self-compassion in clinical samples, such as veterans with PTSD (Kearney et al., 2013). Furthermore, enhanced self-compassion was found to partially mediate the reductions in PTSD symptoms and depression.

### **App-Based Mindfulness Interventions**

There has been a recent explosion of smartphone apps offering mindfulness practices to the general public, which offer a plethora of benefits to users including scheduling flexibility, reduced cost, and improved access (Mrazek et al., 2019). A 2015 review identified over 500 apps claiming to offer mindfulness, though many did not offer comprehensive mindfulness training and the vast majority had not been rigorously tested or empirically supported (Mani et al., 2015). As such, there have been calls to examine both the effectiveness and impact of contemplative training practices delivered via mobile technology (Davidson & Dahl, 2018). There have also been related concerns raised with respect to the premature wide dissemination of these apps, including lack of attention to individual differences in learning or skill acquisition, delivery of quality content, and effectiveness compared traditional face-to-face support in learning these practices (Van Dam et al., 2018b). Some meditation teachers have also voiced concerns related



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to mindfulness being presented in apps as a “simple,” standalone tool for relaxation or sleep, without providing more context or linking it to other contemplative practices such as compassion (Lukoff et al., 2020).

Nonetheless, emerging studies suggest that mindfulness apps are a promising avenue through which users can improve their mental health and well-being (Gál et al., 2021). For example, a recent meta-analysis of technology-enabled mindfulness programs identified small-to-medium effects sizes for reductions in negative affectivity, including stress and depressive symptoms (Victorson et al., 2020). The average length of the programs included in the review was six weeks, though only six of the studies were disseminated specifically via app-based platforms. A meta-analysis of smartphone apps that included mindfulness and acceptance practices demonstrated reduced psychological distress and possibly enhanced self-compassion, though the availability of evidence for improving self-compassion was relatively weak (Linardon, 2020).

The Headspace app has been the most widely studied app to date and has garnered some empirical support via RCTs (e.g., Economides et al., 2018; Howells et al., 2016). This app offers a range of meditation practices, both guided and unguided, and didactic training is provided by a Tibetan Buddhist monk (Flett et al., 2020). It includes an introductory structured program, which is 10 days in length, with 10 minutes per day of mindfulness practice per day. It also offers a host of other psychological tools for sleep and other programming. In a sample of medical students, use of the Headspace app over 30 days improved well-being and reduced perceived stress compared to a control condition (Yang et al., 2018). In another study, first year university students were provided with three-month access to the Headspace app (Flett et al., 2020). While the primary intention-to-treat analysis showed no difference in improvement in psychological

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distress compared to a control condition, a per protocol analysis of those students who accessed and used the app showed reduced psychological distress. Other app-based mindfulness programs have also shown promise. For example, a recent study showed that a seven-day mindfulness program delivered via an app (developed specifically for the study) used for 28 days (i.e., the program was repeated four times) was associated with reduced stress and depressive symptoms compared to an active control condition (Lahtinen et al., 2021). Each practice in this program lasted for 10 minutes and one practice was described as LKM.

Studies of brief mindfulness interventions (i.e., less than two weeks) using smartphone apps have also shown some promise in improving mental health in non-clinical samples. For example, among university students, two popular mindfulness smartphone apps, Headspace and Smiling Mind, used for 10 minutes a day for 10 days have been associated with reduced depressive symptoms, and increased mindfulness, resilience, and college adjustment compared to an attention control placebo (Flett et al., 2019). In a non-clinical adult sample, participants who used the meditation app Headspace for 10 days reported decreases in depressive symptoms and improvements in positive affect compared to an attention app control group (Howells et al., 2016). However, there were no observed changes in negative affect, satisfaction with life, or flourishing. Lastly, in study of the Calm app, another publicly available app, participants showed improvements in well-being following a seven-day course delivered via the app, though this was an uncontrolled study (Clarke & Draper, 2020).

Despite some promising findings, the evidence remains mixed. One challenge in interpreting this growing body of literature is the high degree of variability in terms of what is offered and accessed within mindfulness apps. For example, some apps offer simple guided practices or meditation timers and others include more comprehensive training and education

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(Gál et al., 2021; Mani et al., 2015). Much of the literature to date has examined the efficacy of a specific app in its entirety, or the efficacy of structured programs within an app (e.g., Headspace). However, due to the range of practices offered within mindfulness apps, it is also important to understand more specifically the benefits of individual practices or combinations of these practices. To our knowledge, there have been no studies of brief, standalone LKM app-based practices to date. A recent app-based study reported that a LKM practice was offered within the broader 28-day mindfulness training, but did not describe benefits specific to the LKM meditation practice or how often this practice occurred in the intervention (Lahtinen et al., 2021). Similarly, an exploratory study utilizing the Stop, Breathe, Think app in a sample of college students on a waitlist for counselling services described LKM-based options offered on the app but did not specify whether these were practiced by participants (Levin et al., 2020). The current research sought to fill this gap in the literature by exploring possible mental health and well-being benefits of a standalone, brief LKM practice delivered via smartphone app with relatively little training to mirror a way that this may be used in various apps by the general public.

### **Possible Moderators of the Effectiveness of Brief LKM**

Broadly speaking, individual differences can help explain mixed findings and determine who may benefit most from psychiatric interventions (Kraemer et al., 2002). To date, there have been few studies that have examined moderators in the context of LKM. Grounded in past theory and research, the following moderators of the LKM intervention effects were explored in the current study: trait mindfulness, fear of compassion for self, and frequency of app use (i.e., dose).

### *Trait Mindfulness*

In the Buddhist tradition, a variety of meditative practices are typically used together rather than as standalone practices (Shonin et al., 2015). It has been suggested that having an attentional stability derived from mindfulness practices helps to provide a platform on which to develop further loving-kindness or compassion-based practices (The Dalai Lama, 2001). There is some evidence to suggest that this may be the case – for example, practicing both mindfulness meditation and LKM led to more improvements in mental health outcomes compared to a LKM only practice (Sears & Kraus, 2009). However, the role that trait mindfulness may play in who benefits most from LKM practice is unclear. To date, some studies have shown that those with higher levels of trait mindfulness may benefit more from mindfulness practices (Ratcliff et al., 2021; Shapiro et al., 2011). For example, relative to a control condition, MBSR participants with higher baseline levels of trait mindfulness demonstrated greater benefit from the intervention than those with lower baseline levels (Shapiro et al., 2011). Trait mindfulness has also been found to moderate the effects of state mindfulness on anxiety, wherein anxiety only decreased in those with high trait mindfulness, but not other outcomes in a brief mindfulness intervention (Sousa et al., 2021). Taken together, findings are somewhat mixed though there does seem to be some support that trait mindfulness may play a moderating role in MBIs. As such, understanding whether trait mindfulness may influence outcomes from LKM seems to be an important gap in the literature.

### *Fear of Compassion for Self*

Some people may have a fear of being self-compassionate, and may find relating to themselves with self-compassion unpleasant or threatening (Gilbert et al., 2011). As such, they may have some resistance to initial efforts of providing themselves with kindness or compassion.

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Fear of compassion for self has been associated with mental health difficulties such as depression (Kirby et al., 2019). Given that enhancing self-compassion is one way that LKM may offer mental health benefits, exploring fear of compassion for self as a moderator of brief LKM practice is important in understanding this relationship further. To our knowledge, this has not been previously explored as a moderator in LKM.

### *Frequency of App Use (Dose)*

The issue of dosage remains an important area of inquiry in field of MBIs, with both mixed research and lack of attention in the literature (Davidson & Dahl, 2018). In order to benefit from MBIs, the frequency and duration (i.e., dose) of meditation practice has been highlighted as potentially important, with some authors suggesting that larger doses more likely to produce larger effects (Creswell, 2017). However, to date research findings have been mixed.

Interestingly, a review of the FIM interventions found few significant dose-response relations in terms of outcomes (Zeng et al., 2017). Similarly, a review of interventions utilizing the FIMs for depressive symptoms found no direct link between practice time and outcomes (Lv et al., 2020). However, dose-response relations have been found in some studies of LKM (Fredrickson et al., 2017). For example, in a six-session LKM workshop for novice meditators, duration of meditation was associated with increased positive emotions. These effects were observed both between-persons and within-person. The frequency and duration of LKM practice was more closely associated with daily positive emotions relative those who practiced mindfulness meditation (control group), when within-person dose-response effects were examined. Similarly, in a seven-week LKM intervention, time spent meditating significantly predicted positive emotions post-intervention (Fredrickson et al., 2008).

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Mixed dose-response relations have also been observed in app-based mindfulness interventions (Kozlov et al., 2020). In a study of a brief app-based mindfulness intervention, the frequency of app use did not moderate the effects during the 10-day intervention period, although there was high usage ( $M = 8.34$  days) during this formal intervention period (Flett et al., 2019). However, during the longer discretionary period of app use (30 days), when there was more variability in use, the amount of app use significantly moderated the effect of the intervention on changes in depressive symptoms, mindfulness, anxiety, and college adjustment, with greater use associated with better outcomes. Similarly, in a study of first year university students utilizing the Headspace app for three months, those who used the app more frequently showed reductions in psychological distress compared to non-users, while there were no observed benefits with low use of the app compared to non-users (Flett et al., 2020). Other studies have found that more frequent use is not always necessary and that intermittent use of the Calm app – defined as using the app three to five times out the seven day intervention – was as beneficial as high use (six to seven days) in terms of increasing mindfulness and well-being after brief use, although there was no control group in this study (Clarke & Draper, 2020).

### **The Present Study**

The present study was conducted to extend the literature on the use of brief, app-based meditation practices by investigating the efficacy of a brief LKM practice, delivered through an app-based platform. To our knowledge, this is the first study to investigate a standalone LKM in a brief app-delivered format, which is important to be able to isolate the unique benefits of this practice. In a sample of university students, this research utilized a two-arm, pre-post RCT design to test a brief LKM intervention, delivered through the *Insight Timer* app, compared to an attention control condition, delivered through the *Evernote* app. The control group app involved

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list making and has been used as a digital placebo control in past app-based mindfulness studies (Flett et al., 2019). Participants utilized their assigned app for a 10-day period. The primary outcome variable was depressive symptoms and the secondary outcome variables were perceived stress, negative affect, positive affect, and self-compassion. The primary research questions (1-5) and hypotheses (1-5) are detailed below. The secondary aim of the proposed research was to explore trait mindfulness, fear of compassion for self, and frequency of app use (i.e., dose), as possible moderators of treatment outcome. The secondary research questions (6-8) and exploratory hypotheses (6-8) are also detailed below. Given the absence of data regarding user experiences with app-based LKM, additional data was collected regarding participants' perceptions of the usefulness and impact of *Insight Timer* (or *Evernote*) on their mental health and well-being, as well as any specific positive or negative experiences related to the intervention.

### ***Primary Research Questions and Hypotheses***

**Research Question 1.** Does a brief app-based LKM practice reduce depressive symptoms compared to a control condition?

**Hypothesis 1.** Previous evidence suggests that brief app-based mindfulness interventions can reduce depressive symptoms in non-clinical samples (Flett et al., 2019; Howells et al., 2016) and that LKM is associated with reduced depressive symptoms (Fredrickson et al., 2008; Hofmann et al., 2015; Shahar et al., 2015). Taken together, it was hypothesized that participants in the LKM condition would report a significant reduction in depressive symptoms from pre- to post-intervention compared to participants in the control condition.

**Research Question 2.** Does a brief app-based LKM practice reduce perceived stress compared to a control condition?

**Hypothesis 2.** There has been some mixed evidence with respect to LKM and stress (Galante et al., 2014). However, there is some evidence to support the potential for LKM to reduce stress (Totzeck et al., 2020; Wallmark et al., 2013) and evidence to support the use of brief app-based mindfulness practices to reduce stress (Economides et al., 2018). Thus, it was hypothesized that participants in the LKM intervention condition would report a significant reduction in perceived stress from pre- to post-intervention compared to participants in the control condition.

**Research Question 3.** Does a brief app-based LKM intervention reduce negative affect compared to a control condition?

**Hypothesis 3.** There is evidence that LKM reduces negative affect (Hofmann et al., 2015; May et al., 2014). Thus, it was hypothesized that participants in the LKM intervention condition would report a significant reduction in negative affect from pre- to post-intervention compared to participants in the control condition.

**Research Question 4.** Does a brief app-based LKM intervention increase positive affect compared to a control condition?

**Hypothesis 4.** Previous evidence has suggested that LKM interventions enhance positive affect (Zeng et al., 2015). As such, it was hypothesized that participants in the LKM intervention condition would report a significant increase in positive affect from pre- to post-intervention compared to participants in the control condition.

**Research Question 5.** Does a brief app-based LKM intervention increase self-compassion compared to a control condition?

**Hypothesis 5.** Previous LKM intervention studies have found increases in self-compassion (e.g., Shahar et al., 2015; Weibel et al., 2017). As such, it is hypothesized that



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participants in the LKM intervention would report significantly increases self-compassion from pre- to post-intervention compared to participants in the control condition.

### *Secondary Research Questions and Hypotheses*

There is a lack of prior research examining moderators of LKM treatment efficacy. As such, the hypotheses regarding treatment moderators were all exploratory in nature.

**Research question 6.** Does baseline trait mindfulness moderate the LKM intervention effects?

*Hypothesis 6.* There is some evidence to suggest that those with higher levels of trait mindfulness may benefit more from MBIs (Ratcliff et al., 2021; Shapiro et al., 2011). As such, it was hypothesized that higher baseline levels of trait mindfulness would be associated with better outcomes in the LKM intervention, compared to lower baseline levels.

**Research question 7.** Does baseline fear of compassion for self moderate the LKM intervention effects?

*Hypothesis 7.* Given that those who are higher in fear of compassion for self may, at least initially, have more difficulty relating to themselves with kindness or compassion (Gilbert et al., 2011), it was hypothesized that higher baseline fear of compassion towards the self would attenuate the benefits of the LKM intervention, compared to lower fear of compassion.

**Research question 8.** Does the frequency of app use (dose) moderate the LKM intervention effects?

*Hypothesis 8.* Some studies have found a dose-response effect for kindness-based meditations (see Galante et al., 2014), whereas others have found no dose-response relation (Lv et al., 2020; Zeng et al., 2017). While the research is indeed mixed, it was hypothesized that

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more frequent app use would be associated with greater benefits from the LKM intervention, compared with less frequent use.

## Method

### Participants

Participants were undergraduate students from the University of British Columbia's Okanagan (UBCO) campus who were recruited through the Department of Psychology's research participant pool. The purpose of the study was described to potential participants as the following: *to examine how smartphone apps may influence well-being among university students*. To be eligible for inclusion in the study, participants had to be at least 18 years of age, be enrolled as an undergraduate student at UBCO, and have daily access to a personal smartphone (iPhone or Android). Exclusion criteria included previous diagnoses of PTSD, schizophrenia or psychosis. Participants with these diagnoses were excluded given low, but potential risk for adverse events such as re-experiencing or exacerbation of psychotic symptoms (Creswell, 2017).

Eligible participants were offered up to 3.0 course credits (generally worth 3% of course grade) for their participation in the study. The components of the study included an initial lab-based session (which included an orientation and completion of a pre-intervention questionnaire), a 10-day intervention period (which included daily use of the assigned app and a daily adherence question), and completion of a post-intervention questionnaire online. To receive full credit, participants were required to complete at least 70% of the daily assessments (seven out of 10 days). Those who completed less than 70% received prorated credits for their participation. The study protocol was approved by the UBCO research ethics board prior to conducting the study.

### **Power Analysis**

An a priori power analysis was performed for the primary outcome variable, depressive symptoms, to estimate the sample size needed for the study. The power analysis was based upon data from recent studies of brief online or app delivered mindfulness interventions. The effect sizes used to inform the power analysis were:  $d = .23$ ,  $d = .17$  (derived from a recent RCT of two different mindfulness meditation apps on depressive symptoms; Flett et al., 2019),  $d = .36$  (estimated from effect of a recent app-based mindfulness intervention on depressive symptoms; Howells et al., 2016),  $d = .33$  (estimated from effects on depression/anxiety from a brief online mindfulness intervention in Cavanagh et al., 2018), and  $d = .41$  (estimated from effects on depression/anxiety from a brief online mindfulness intervention in Cavanagh et al., 2013). An average of the five effect sizes,  $d = .30$ , was utilized in the power calculation conducted with G\*Power 3.1 (Faul et al., 2007), with alpha set to .05, and power set to .80. Based on this calculation, the recruitment target specified by G\*Power was 220 participants (roughly 110 per condition). While not available at the time of our a priori power analysis, a recent meta-analysis of effects of the FIMs (which includes LKM) on depressive symptoms in RCTs yielded an effect size of  $d = 0.38$ , which is even higher than the effect size utilized in the above analysis (Lv et al., 2020). Also of note, the studies used to inform the above power analysis (i.e., those with an average effect size of .30) used sample sizes ranging from 104 (Cavanagh et al., 2013) to 208 (Flett et al., 2019). Given that our secondary aim was to explore possible moderators (which require greater power to detect significant effects), we elected to continue with recruitment of participants after we reached the target sample of 220. Specifically, data was collected from October 19, 2019 to April 8, 2020 (i.e., the deadline to complete research studies for course credit for the school year).

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### **Design**

A two-arm RCT was utilized to test the efficacy of a brief (10-day) app-based LKM practice on change in depressive symptoms relative to a control group. Secondary outcome variables included changes in perceived stress, negative affect, positive affect, and self-compassion. Outcomes were evaluated using a pre-post design. In addition to the main study protocol, participants were invited to complete an optional follow-up survey 30 days post-intervention following a period of discretionary app use. Due to the challenges inherent in conducting follow-up surveys within an undergraduate subject pool (e.g., follow-up surveys often can't qualify for course credit because they fall outside the school term), this study component was considered exploratory and is outside the scope of this dissertation.

### **Procedure**

Participants were recruited via the psychology research participant pool at UBCO. Interested participants were invited to attend an initial research lab session with a trained research assistant, where they were assessed for eligibility and provided informed consent. Each participant was subsequently randomized to either the LKM intervention or Evernote control condition. Participants were randomized using block randomization to ensure a relatively equal balance of participants to either the intervention or the control group. An online randomization program ([www.randomizer.org](http://www.randomizer.org)) was used to conduct the block randomization.

During the initial lab session, all participants completed an online demographic information questionnaire and baseline measures of depressive symptoms, perceived stress, negative affect, positive affect, self-compassion, trait mindfulness, and fear of compassion for self. Upon completion of the baseline measures, a trained research assistant demonstrated to participants how to download the *MetricWire* app (for the daily diary assessment component)

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and either the *Insight Timer* app (intervention) or the *Evernote* app (control). The research assistant then read a standardized description of the intervention or control condition activity to the participant (see Appendix A). Following the description of the task, the research assistant demonstrated to the participant how to use the assigned app and provided instructions on how to use the app during the 10-day intervention period. Participants were asked to start their assigned app activity the following day and were asked to refrain from using other meditation practices (including yoga) or apps for the 10-day duration of the study. During the lab session, participants were also invited to complete an optional online follow-up survey 30 days post-intervention, with discretionary app use during this period. Participants who completed this portion of the study received a \$5 Starbucks card (this study component was considered exploratory and is outside the scope of this dissertation). Students were informed to contact either Ms. Bakker or Dr. Holtzman if additional support was needed during the duration of the study.

Participants were instructed to utilize their assigned app exercise once daily, prior to 9pm, for 10 consecutive days. All participants received a notice with a reminder to complete the assigned activity at 8pm and a prompt to complete the daily diary assessment measures at 9pm via *MetricWire* on their smartphone daily for 10 days. *MetricWire* ([www.metricwire.com](http://www.metricwire.com)) is an app designed to aid in the collection of experience-sampling data, freely downloadable for participants, and compatible with both iOS or Android devices. Only a single item (inquiring about app adherence) was used from the daily diary assessment in the current study. Following the intervention phase, participants again completed measures of depressive symptoms, perceived stress, negative affect, positive affect, and self-compassion. Participants were asked to rate the perceived usefulness of the app activity and the impact that they perceived their assigned activity to have on their well-being and/or mental health. They were also asked whether they

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experienced any positive or negative effects related to the use of their app activity. We sought to explore any negative effects of app use in order to accurately report any potential adverse events from app-based LKM (Van Dam et al., 2018b).

### ***LKM Intervention***

For the intervention group, the *Insight Timer* app was utilized (<https://insighttimer.com>). *Insight Timer* is a free smartphone application that is available for both iPhone and Android devices. *Insight Timer* provides over 28,000 guided meditations as well as a timer for meditation practice. For the purposes of the current study, the 9-minute guided LKM from the UCLA Mindful Awareness Research Centre, which is freely available on the app, was utilized. This length of practice was chosen given that it was close to 10 minutes, which is the most frequent session duration found in other studies of app-based mindfulness practices and a common length of meditation practices offered via mindfulness apps available to the general public (Flett et al., 2019; Gál et al., 2021; Lahtinen et al., 2021). Participants were asked to do the 9-minute LKM practice each day, and were instructed not to use other parts of the app for the duration of the study. During the LKM guided meditation, participants were led to silently repeat loving-kindness phrases to themselves while also engaging in mindful breathing. During the practice, participants were guided to extend compassionate phrases first to a loved one, then oneself, and then to others (a neutral person, and a person with whom the participant experienced some difficulty).

### ***Evernote Control Condition***

*Evernote* was utilized for the placebo control condition ([www.evernote.com](http://www.evernote.com)). *Evernote* is a popular note-taking application that has a basic free download option on both iPhone and Android devices. Note taking apps, including the *Evernote* app, have been used as attention

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placebo controls in recent studies of brief app-based mindfulness interventions to control for treatment expectancy or account for any digital placebo effects (Flett et al., 2019; Howells et al., 2016). Participants were asked to set a timer on their smartphone and use the app for nine minutes each day during the 10-day intervention period. Instructions were provided to participants that were modelled after Flett and colleagues (2019), and the attention control task was described to participants as an “organizational reminiscing” task, which consisted of listing all activities they recalled doing on the same day last week in a checklist format (see Appendix A for full script).

### *Change to Procedure During the COVID-19 Pandemic*

As a result of the COVID-19 pandemic, the study protocol was moved entirely online in accordance with university policy in March 2020. Instead of the lab-based initial session being conducted in person, informed consent was obtained by adding the consent form to the beginning of the online survey (rather than being read and signed in person), and having the research assistant available via email to answer any questions. Participants also answered inclusion/exclusion criteria questions online. All materials and instructions (i.e., how to download the apps and condition instructions) were sent to participants via email, and again a research assistant was available via email to answer any questions. Otherwise, the rest of the study was unchanged. A total of 47 participants (15.1%) in the study completed the study in this manner.

## **Measures**

### *Demographics and Mindfulness/Meditation Experience Questionnaire*

Relevant demographic information was collected at baseline through a demographics questionnaire. Age, gender, race/ethnicity, relationship status, and previous mental health



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conditions were assessed. A detailed assessment of previous experience with mindfulness or meditation practices (including LKM) was conducted in order to accurately describe the sample in terms of prior exposure to these practices.

### ***Outcome Measures***

**Depressive Symptoms.** The Center for Epidemiological Studies Depression Scale (CESD; Radloff, 1977) is a 20-item self-report measure of depressive symptoms experienced over the past week. Items (e.g., *I felt depressed*) are rated on a scale ranging from 0 (*rarely or none of the time/less than one day*) to 4 (*most or all the time/5 to 7 days*). Scores on the CESD range from 0 to 60, with higher total scores reflecting greater symptoms of depression. A score of greater than or equal to 16 is often used to identify depressive symptoms of clinical concern (Unützer et al., 2002). Scores of 16-20 are considered to reflect mild depressive symptoms, 21 – 26 moderate, and > 26 is considered severe. The CESD has been widely utilized in studies of emerging adults and in studies of brief mindfulness interventions with recent Cronbach's alphas of .89, .91, and .93 (Flett et al., 2019). Cronbach's alpha for the current study was .90.

**Perceived Stress.** The Perceived Stress Scale (PSS; Cohen & Williamson, 1988) is a 10-item self-report measure used to assess perceived stress over the last month. For the purposes of our study, participants were asked about their perceived stress over the past week. Participants responded to items (e.g., *In the last month, how often have you felt nervous and “stressed”?*) using a scale from 0 (*never*) to 4 (*very often*). Scores on the PSS range from 0 to 40, with higher total scores indicating higher levels of perceived stress. The PSS has been utilized in recent studies in university samples with good internal consistency (Flett et al., 2019). Cronbach's alpha in the current study was .86.

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**Positive and Negative Affect.** The Positive and Negative Affect Scale (PANAS; Watson et al., 1988) is a 20-item self-report measure. The PANAS has 10 positive (e.g., *enthusiastic*) and 10 negative affective descriptors (e.g., *upset*). Participants rated whether they experienced these affective states in the past week from 1 (*very slightly or not at all*) to 5 (*extremely*). Scores for each subscale range from 10 to 50 and higher scores are indicative of greater affect. The PANAS has been used extensively in university samples and has recently demonstrated good internal consistency for both negative affect (.85 to .89) and positive affect (.84 to .89; Sears & Kraus, 2009). Cronbach's alphas in the current study were .89 (positive affect) and .88 (negative affect).

**Self-Compassion.** The Self-Compassion Scale (SCS; Neff, 2003a) is a self-report measure that assesses the degree to which participants treat themselves self-compassionately in times of difficulty. The SCS is comprised of 26-items (e.g., *When I'm going through a very hard time, I give myself the caring and tenderness I need*) that are rated from 1 (*almost never*) to 5 (*almost always*). There are six subscales that make up the SCS: self-kindness, common humanity, mindfulness, self-judgment, isolation, and over-identification. A total score is computed from the six subscales, which together provide an overall measure of self-compassion (Neff, 2003a; Neff et al., 2017). Scores can range from 26 to 130, with higher scores reflecting greater self-compassion. There is debate among researchers regarding the appropriateness of including both self-compassionate and uncompassionate response items (Muris et al., 2019). However, there is recent psychometric evidence for utilizing either a total score to measure more general self-compassion, or the six subscales to assess specific factors (Neff, 2019). Given that the proposed study examined overall levels of self-compassion, the total score was used. The SCS has been extensively used in undergraduate samples (Neff, 2019). Cronbach's alpha for the total SCS in the current study was .90.

### *Moderators*

**Mindfulness.** The Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) was used to measure trait level mindfulness in daily life. The FFMQ is a 39-item self-report measure that taps into five facets of mindfulness – describing, acting with awareness, non-judging of inner experience, non-reactivity to inner experience, and observing. Respondents rate each item (e.g., *I perceive my feelings and emotions without having to react to them*) on a scale of 1 (*never or very rarely true*) to 5 (*very often or always*). Typically, each subscale is scored and described independently. However, for the purposes of the current study, we utilized a full scale composite score to reflect overall trait mindfulness (the scores from the observe subscale are not included in this full scale). This latter approach was based on psychometric support of a four factor hierarchical model in relatively novice meditators (e.g., Gu et al., 2016; Williams et al., 2014) and has been used recently in an undergraduate sample with a Cronbach's alpha of .93 (Cavanagh et al., 2018). The current Cronbach's alpha (not including the observe items) was .91.

**Fear of Compassion for Self.** The Fear of Compassion Scale (Gilbert et al., 2011) is a self-report measure that is comprised of three subscales: fear of compassion for self, fear of compassion from others, and fear of giving compassion to others. The fear of compassion for self (FOCS) subscale was utilized in this study. FOCS has 15 items (e.g., *I fear that if I am more self-compassionate I will become a weak person*) that are measured on a scale ranging from 0 (*don't agree at all*) to 4 (*completely agree*). Higher scores are reflective of greater fear of offering kindness and compassion towards oneself. It has been utilized in undergraduate samples (Joeng & Turner, 2015) with recent a Cronbach's alpha of .95 for the FOCS (Kelly & Dupasquier, 2016). Cronbach's alpha for the current study was .92.

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**Daily Diary Assessment of App Use.** Participants completed a daily diary assessment at 9pm for 10 consecutive days. There were a number of items included in this daily assessment, but for the purposes of the current study a single item inquiring about app adherence was used. Participants were asked to answer yes or no to the following item: *Did you complete your assigned app activity today?*

### ***User Experience Questions***

Participants were asked how useful they found their assigned app (*overall, how useful was your assigned app activity?*), and ratings were provided on a scale of 1 (*not at all useful*) to 5 (*extremely useful*). Participants were also asked about whether they felt their app enhanced their mental health and/or well-being (*overall, what impact do you think the app activity had on your well-being and/or mental health?*). Ratings were provided on a scale of 1 (*very negative*) to 5 (*very positive*). Participants were also asked whether they experienced any positive or negative effects related to using the app. For the purposes of the current study a quantitative yes/no format was used, though qualitative data for user experience was also collected. A number of open-ended questions about what participants liked most and least about their assigned app activity were collected but are beyond the scope of the current study.

### **Statistical Analysis Plan**

Preliminary analyses included descriptive statistics for the demographic variables, previous experiences with mindfulness and meditation practices, and measures of depressive symptoms, perceived stress, negative affect, positive affect, self-compassion, trait mindfulness, fear of compassion for self, and frequency of app use (both aggregated for the sample and separated by condition). To ensure that randomization was successful and that analysis of covariance (ANCOVA) was appropriate for the data, preliminary analyses also examined

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whether there were differences between the intervention and control groups on key study variables, including demographic factors (e.g., age, gender, previous experience with mindfulness or meditation practices, and previous experience with LKM) and baseline values of the outcome variables (depressive symptoms, perceived stress, negative affect, positive affect, and self-compassion). Chi-square tests were conducted for categorical variables and independent *t*-tests for continuous variables.

An intention-to-treat (ITT) approach to analysis was used to minimize bias (White et al., 2012). As such, regardless of completion, all participants were included in the analysis, in the group to which they were randomized. To answer the primary research questions, an ANCOVA approach modeled with the change scores between pre- and post-intervention measures as the outcome variable was utilized. An ANCOVA approach was chosen given that it achieves lower variability and greatest power compared other methods and is the preferred method to analyse pre-post treatment data (Connell et al., 2018). The ANCOVA change approach was used to determine if there was a difference in pre-post change in depressive symptoms between the LKM and Evernote condition while adjusting for pre-treatment depressive symptoms. A parallel set of analyses were run to examine the secondary outcome variables (perceived stress, negative affect, positive affect, and self-compassion). To further explore pre-post differences in study variables, simple contrasts (*t*-tests) for difference in pre-post scores for study variables for each condition were explored. Cohen's *d* was calculated, which takes into account the correlation between measurements (Lakens, 2013). All statistical analyses were conducted using IBM SPSS Statistics 27.

To answer the exploratory research questions regarding moderation, each proposed moderator of intervention effectiveness [trait mindfulness, fear of compassion for self, and

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frequency of app use (i.e., dose)] was individually explored. The PROCESS macro for SPSS (version 3; Hayes, 2018) model 1, simple moderation, was used to conduct each of the moderation analyses. The effect of LKM (vs. Evernote control) on change in depressive symptoms, perceived stress, negative affect, positive affect, and self-compassion, by each moderator was tested using ordinary least squares (OLS) regression. For each simple moderation model, the predictor ( $X$ ) was the condition (LKM or Evernote), and the outcome ( $Y$ ) was the change score (i.e., Time 2 – Time 1). Time 1 for the variable was entered in the model as a covariate. The moderator (i.e., mindfulness, fear of compassion for the self, or frequency of app use) was entered in the model as the moderator ( $W$ ). Lastly, between-group differences in the user experience were explored using independent  $t$ -tests for continuous variables and Chi-square tests or Fisher's exact test for categorical variables.

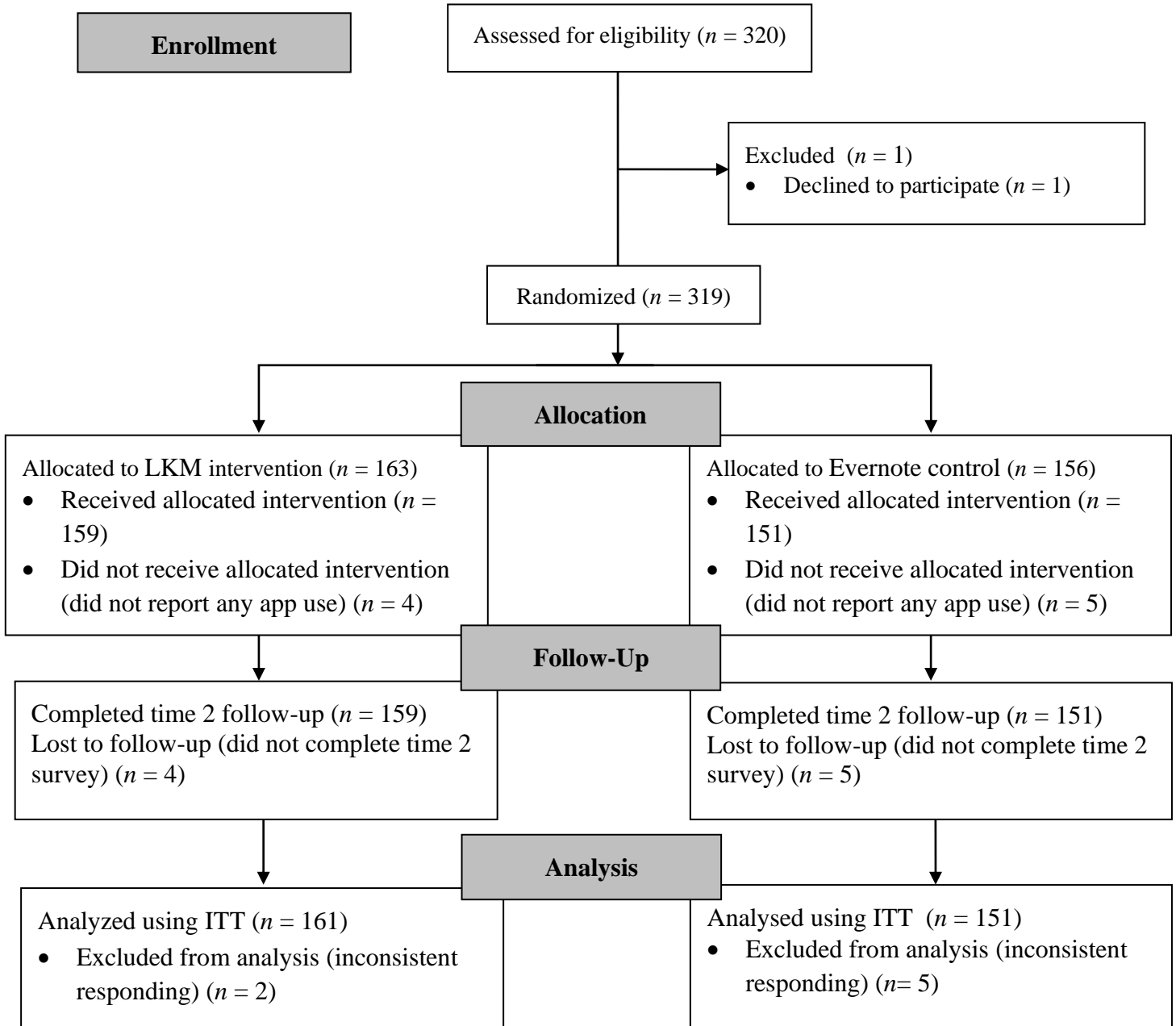
## Results

### Participant Flow

Figure 1 outlines the flow of participants through the study. Of the 319 participants randomly assigned to either the LKM intervention ( $n = 163$ ) or the Evernote control condition ( $n = 156$ ), 310 (97%) completed at least part of the intervention (defined as accessing the *MetricWire* app to report at least one day of app use) as well as questionnaires at both pre- and post-intervention. Nine participants did not complete any portion of the intervention (i.e., did not access *MetricWire* app or report at least one day of app use) and did not complete the post-intervention survey (i.e., lost to follow up;  $n = 4$  LKM;  $n = 5$  Evernote). Missing data for these participants were replaced using the baseline observation carried forward (BOCF) method, which has been found to be an appropriate approach to utilize for participants who did not receive treatment and are missing follow-up data (Twisk et al., 2020). Given that there were only nine participants missing post-intervention data, a secondary per-protocol analysis (PP) was not utilized. Seven participants ( $n = 2$  LKM;  $n = 5$  Evernote) were subsequently removed from analyses due to the detection of possible careless responding. These participants either responded by straight-lining or had rapid response times that would not be likely if they were reading the survey questions properly. A total of 312 participants randomly assigned to either the LKM intervention condition ( $n = 161$ ) or the Evernote control condition ( $n = 151$ ) were included in the final ITT analyses.

**Figure 1**

*CONSORT Flowchart of Participants*





### **Preliminary Analyses**

#### ***Missing Data and Outliers***

Data was examined for missingness. The pattern of missing data was found to be missing completely at random (Little's MCAR  $p = .350$ ) and there was less than 1% of the data missing (once the BOCF was applied). Given the random pattern and very minimal amount of missing data, expectation maximization (EM) was used to impute missing values (Schafer & Graham, 2002).

Data was screened for univariate outliers by inspecting boxplots for all variables. There were 24 univariate outliers across pre- and post-intervention variables ( $n = 14$  LKM;  $n = 10$  Evernote), as assessed by visual inspection of boxplots. Change scores were also assessed for outliers by inspecting boxplots. There were 34 change score outliers across outcome variables ( $n = 15$  LKM;  $n = 19$  Evernote). All outlier scores were adjusted by assigning a value one unit larger (or smaller) than the next extreme score in the condition to avoid disproportionate influence on ANCOVA models without removing the participant from the analysis (Tabachnick & Fidell, 2012).

#### **Sample Characteristics**

Participants were 312 undergraduate students between the ages of 18 and 48 years old ( $M = 19.73$  years,  $SD = 2.66$  years,  $n = 4$  missing). Characteristics of the sample are provided in Table 1. Baseline comparisons revealed no significant differences between conditions on demographic variables including age  $t(306) = -4.75$ ,  $p = .635$ , gender  $X^2(2) = 5.94$ ,  $p = .389$ , and previous mental health condition  $X^2(1) = .02$ ,  $p = .904$ .

**Table 1**

*Characteristics of the LKM and Evernote Groups at Baseline*

Variable	Full sample		LKM		Evernote	
	Mean	SD	Mean	SD	Mean	SD
<b>Age (years)</b>	19.73	2.66	19.66	2.41	19.80	2.91
<b>Gender</b>	N	%	N	%	N	%
Male	74	23.7	38	26.3	36	23.8
Female	236	75.6	121	75.2	115	76.2
Transgender	2	0.6	2	1.2	0	0
<b>Relationship status</b>						
Single	179	57.4	91	56.5	88	58.3
In a relationship	125	40.1	66	41.0	59	39.1
Married/Common Law	7	2.2	4	2.5	3	2.0
Other	1	0.3	0	0	1	0.7
<b>Race/Ethnicity</b>						
White/Caucasian	183	58.7	96	59.6	87	57.6
Black/African Origin	13	4.1	10	6.2	3	2.0
East or Southeast Asian	55	17.6	28	17.4	27	17.9
South Asian	30	9.6	14	8.7	16	10.6
Indigenous	4	1.3	2	1.2	2	1.3
Middle Eastern	4	1.3	0	0	4	2.6
Latino	1	0.3	0	0	1	0.7
Other/Self-Identify	22	7.0	11	6.8	11	7.3
<b>Ever been diagnosed with mental health condition</b>						
Yes	57	18.3	29	18.0	28	18.5
No	255	81.7	132	82.0	123	81.5

In terms of previous meditation or mindfulness experience, 61.2 % of participants ( $n = 191$ ) reported that they had tried at least one practice in the past (see Table 2). Most of these participants reported less than one year of meditation or mindfulness experience ( $n = 129$ ; 41.3 %); 44 (14.1%) reported one to three years, three (1.0%) reported three to five years, and five (1.6%) reported more than five years of experience. A total of 15.4% of the sample ( $n = 48$ ) reported that they had completed a mindfulness or meditation practice in the past week. In terms of experience with a meditation or mindfulness app, 29.8% ( $n = 70$ ) of the sample reported that

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they had previously tried one, however of these participants only 22 had used an app in the past month. Importantly, only 1.3% of the sample ( $n = 4$ ) reported that they had every tried a LKM (or metta meditation) practice, and all four indicated that they had been practicing LKM for less than one year. Of these, only two participants in the sample ( $n = 1$  LKM,  $n = 1$  Evernote) reported that they had completed a LKM in the past six months. Given the small number of participants who had completed LKM in the past six months, and balance between groups, we elected to retain these participants in the total sample to maintain power.

**Table 2**

*Previous Meditation or Mindfulness Experience of the LKM and Evernote Groups at Baseline*

Variable	Full sample N (%)	LKM N (%)	Evernote N (%)	Statistic
<b>Tried meditation or mindfulness</b>				$X^2(1) = .11, p = .738$
Yes	191 (61.2)	100 (62.1)	91 (60.3)	
No	121 (38.8)	61 (37.9)	60 (39.7)	
<b>Amount of experience with meditation or mindfulness</b>				$X^2(4) = 5.02, p = .286$
None	10 (3.2)	5 (3.1)	5 (3.3)	
< 1 year	129 (41.3)	69 (42.9)	60 (39.7)	
1 – 3 years	44 (14.1)	22 (13.7)	22 (14.6)	
3 – 5 years	3 (1.0)	3 (1.9)	0 (0)	
5 + years	5 (1.6)	1 (0.6)	4 (2.6)	
<b>Meditation or mindfulness in past week<sup>a</sup></b>				$X^2(1) = .14, p = .706$
Yes	48 (15.4)	24 (14.9)	24 (15.9)	
No	143 (45.8)	76 (47.2)	67 (44.4)	
<b>Ever used meditation or mindfulness app</b>				$X^2(2) = .06, p = .806$
Yes	93 (29.8)	47 (29.2)	46 (30.5)	
No	219 (70.2)	114 (70.8)	105 (69.5)	
<b>Frequency of mindfulness app use<sup>b</sup></b>				
Not in past month	70 (22.4)	37 (23.0)	33 (21.9)	
1 – 4 times a month	14 (4.5)	7 (4.3)	7 (4.6)	
2 – 3 times per week	7 (2.2)	3 (1.9)	4 (2.6)	
4 or more times per week	1 (0.3)	0 (0)	1 (0.7)	
Daily or almost daily	1 (0.3)	0 (0)	1 (0.7)	
<b>Ever practiced LKM or Metta meditation</b>				Fisher's Exact test, $p = .667$
Yes	4 (1.3)	2 (1.2)	2 (1.3)	
No	307 (98.4)	158 (98.1)	149 (98.7)	
<b>How long have you been practicing LKM or Metta meditation</b>				
Less than 1 year	4 (1.3)	2 (1.2)	2 (1.3)	

<sup>a</sup> This question was only asked to participants who answered yes to previous tried mindfulness or meditation. Percentage calculations reflect the (%) of the full (or group) sample.

<sup>b</sup> This question was only asked to participants who answered yes to ever used meditation or mindfulness app. Percentage calculations reflect the (%) of the full (or group) sample.

<sup>c</sup> This question was only asked to participants who answered yes to ever practiced LKM or metta meditation. Percentage calculations reflect the (%) of the full (or group) sample.

### **Descriptive Analyses**

Pre- and post-intervention scores on all outcome measures, mean change scores, and baseline scores for moderator variables are displayed in Table 3. Independent samples t-tests were conducted to compare baseline scores for outcome variables and moderators between the LKM and Evernote condition. There were no significant differences between groups in terms of depressive symptoms  $t(310) = .72, p = .471$ , perceived stress  $t(310) = .25, p = .805$ , negative affect  $t(310) = 1.13, p = .259$ , positive affect  $t(310) = -.81, p = .419$ , or self-compassion  $t(310) = -.07, p = .942$ . Similarly, there were no significant differences in baseline scores between groups for moderator variables, including trait mindfulness  $t(310) = -.24, p = .813$ , fear of compassion for self  $t(310) = -.09, p = .928$ , and frequency of app use  $t(310) = .08, p = .940$ . In the current study, participants in both groups reported a mean level of baseline depressive symptoms that was in the clinically significant range.

**Table 3**

*Descriptive Statistics for Pre, Post, and Change Scores for Study Variables*

	LKM ( <i>n</i> = 161)			Evernote ( <i>n</i> = 151)		
	Pre M ( <i>SD</i> )	Post M ( <i>SD</i> )	Change M ( <i>SD</i> )	Pre M ( <i>SD</i> )	Post M ( <i>SD</i> )	Change M ( <i>SD</i> )
Depressive symptoms	18.47 (9.95)	16.23 (9.99)	-2.27 (7.93)	17.67 (9.39)	17.45 (10.56)	-.24 (7.44)
Perceived stress	18.93 (6.94)	17.15 (6.62)	-1.74 (5.70)	18.73 (7.08)	18.26 (6.91)	-.51 (5.91)
Positive affect	29.51 (7.39)	29.76 (7.43)	.37 (6.50)	30.18 (7.41)	29.42 (6.89)	-.85 (6.25)
Negative affect	23.35 (7.40)	21.90 (7.25)	-2.30 (6.14)	22.45 (6.47)	21.82 (7.26)	-.61 (5.45)
Self-compassion	75.68 (16.50)	79.70 (17.00)	3.87 (12.49)	75.82 (17.05)	78.47 (17.94)	2.72 (10.29)
Mindfulness	94.38 (17.36)			94.85 (17.54)		
Fear of compassion for self	16.16 (11.42)			16.28 (12.10)		
Frequency app use (days)	8.85 (1.89)			8.83 (1.95)		

**Main Analyses**

*Assumptions*

The assumptions for ANCOVA were examined for each outcome variable. First, the assumption of linear relationships between pre- and change scores for each condition were met as assessed by visual inspection of scatterplots. The assumption of homogeneity of regression slopes was met for all variables as the interaction terms were not statistically significant (all *p*'s >.05). Residuals for interventions and the overall models were normally distributed, as assessed

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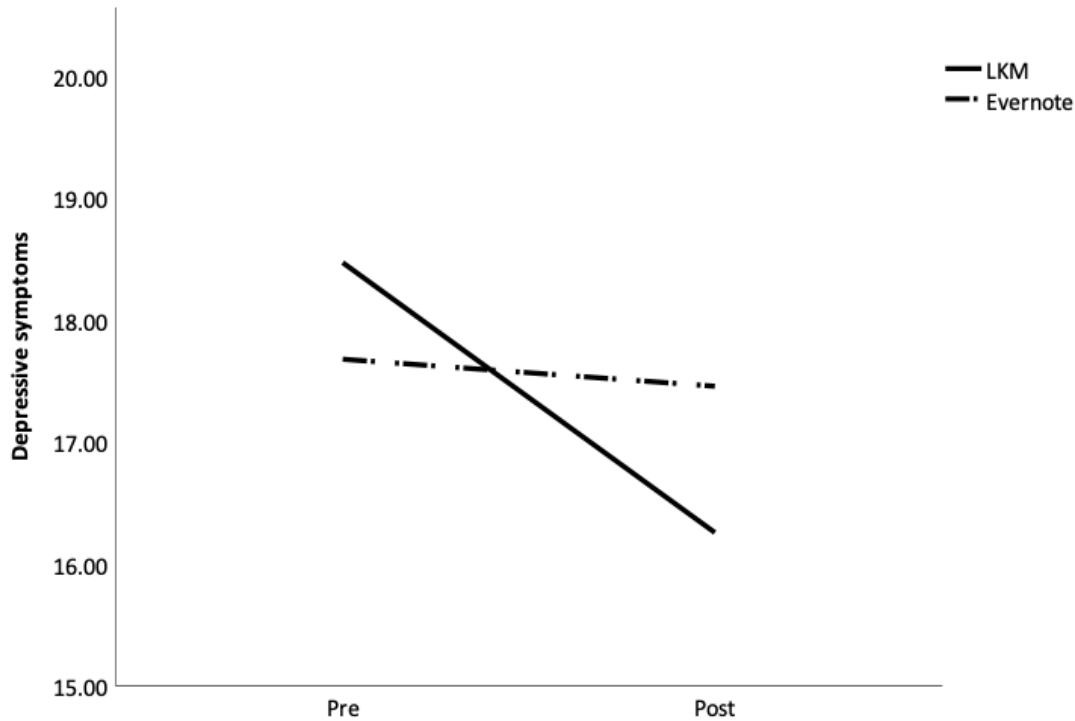
by Normal Q-Q Plot. The assumption of homoscedasticity was met for each variable, as assessed by visual inspection of the standardized residuals plotted against the predicted values. The homogeneity of variances assumptions were met for each variable, as assessed by Levene's test of homogeneity of variance (all  $p$ 's  $>.05$ ). There were no remaining outliers in either condition for all models, as assessed by inspection of studentized residuals for values 3 SD above or below the mean.

### *Depressive Symptoms*

Visual representation of mean depressive symptom scores from pre- and post-intervention for both groups are displayed in Figure 2. After adjusting for pre-intervention depressive symptoms, there was a statistically significant difference in change in depressive symptoms between groups  $F(1, 309) = 4.86, p = .028, \text{partial } \eta^2 = .015$ . Simple contrasts showed that there was a significant decrease in depressive symptoms from pre- to post-intervention in the LKM group,  $t(160) = -3.47, p = .001, d = -.27, 95\% \text{ CI } [-.43, -.12]$ . In the Evernote condition there was no significant difference in depressive symptoms between pre- and post-intervention,  $t(150) = -.36, p = .723, d = -.03, 95\% \text{ CI } [-.19, .13]$ .

Figure 2

*Mean Scores of Depressive Symptoms at Pre- and Post-Intervention for LKM and Evernote Groups*



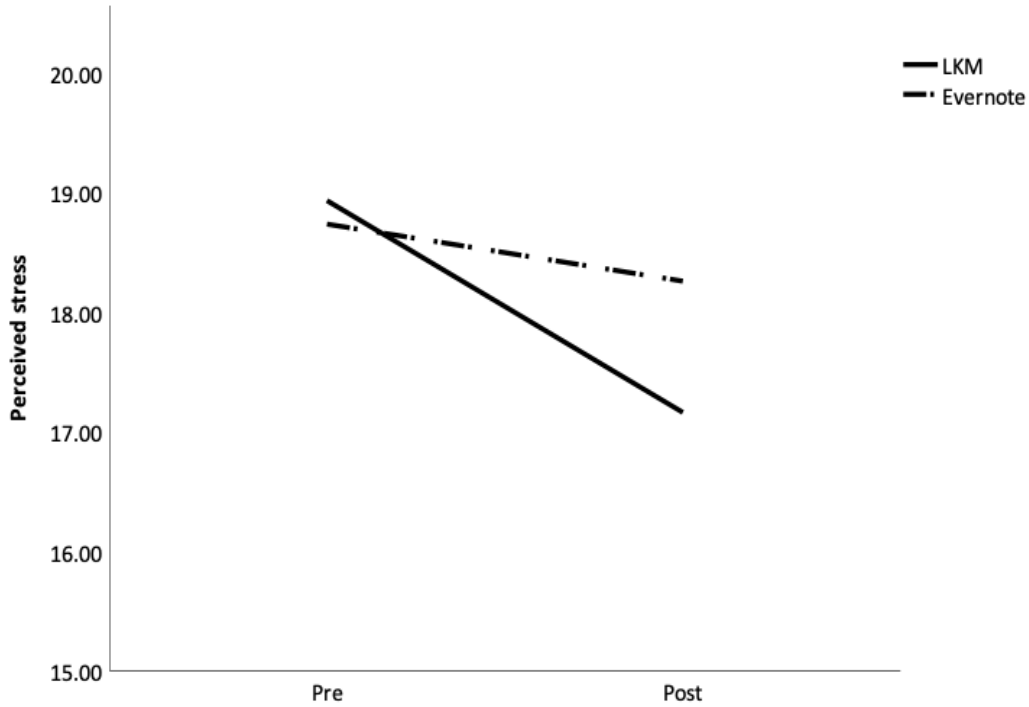
***Perceived Stress***

Visual representation of means of perceived stress from pre- and post-intervention for both groups are displayed in Figure 3. After adjusting for pre-intervention perceived stress, there was a statistically significant difference in change in perceived stress between groups,  $F(1, 309) = 3.91, p = .049, \text{partial } \eta^2 = .013$ . Simple contrasts showed that there was a significant decrease in perceived stress from pre- to post-intervention in the LKM condition (decrease),  $t(160) = -3.87, p < .001, d = -.31, 95\% \text{ CI } [-.47, -.15]$ . There was no significant difference in perceived stress in the Evernote condition from pre- to post-intervention,  $t(150) = -.97, p = .335, d = -.08, 95\% \text{ CI } [-.24, -.08]$ .



Figure 3

*Mean Scores of Perceived Stress at Pre- and Post-Intervention for LKM and Evernote Groups*

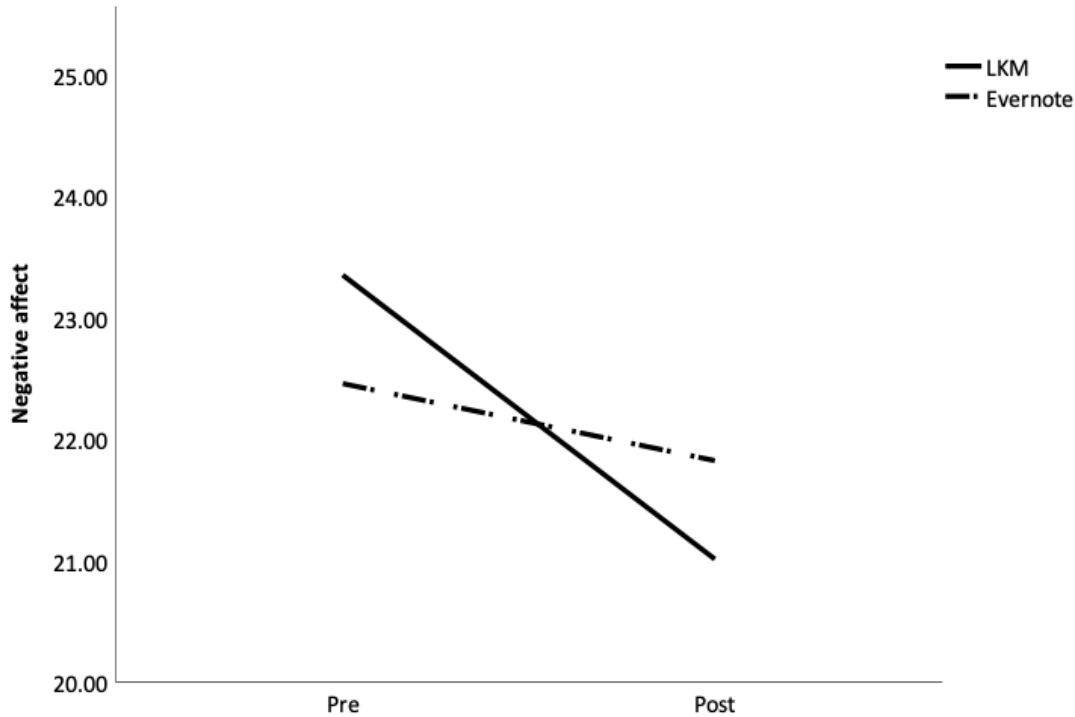


### *Negative Affect*

Visual representation of means of negative affect from pre- and post-intervention for both groups are displayed in Figure 4. After adjusting for pre-intervention negative affect, there was a statistically significant difference in change in negative affect between groups,  $F(1, 309) = 5.26, p = .022, \text{partial } \eta^2 = .017$ . Simple contrasts showed that there was a significant decrease in negative affect from pre- to post-intervention in the LKM condition,  $t(160) = -4.75, p < .001, d = -.37, 95\% \text{ CI } [-.53, -.21]$ . There was no significant difference in negative affect in the Evernote condition from pre- to post-intervention,  $t(150) = -1.40, p = .165, d = -.11, 95\% \text{ CI } [-.27, .05]$ .

Figure 4

*Means Scores of Negative Affect at Pre- and Post-Intervention for LKM and Evernote Groups*

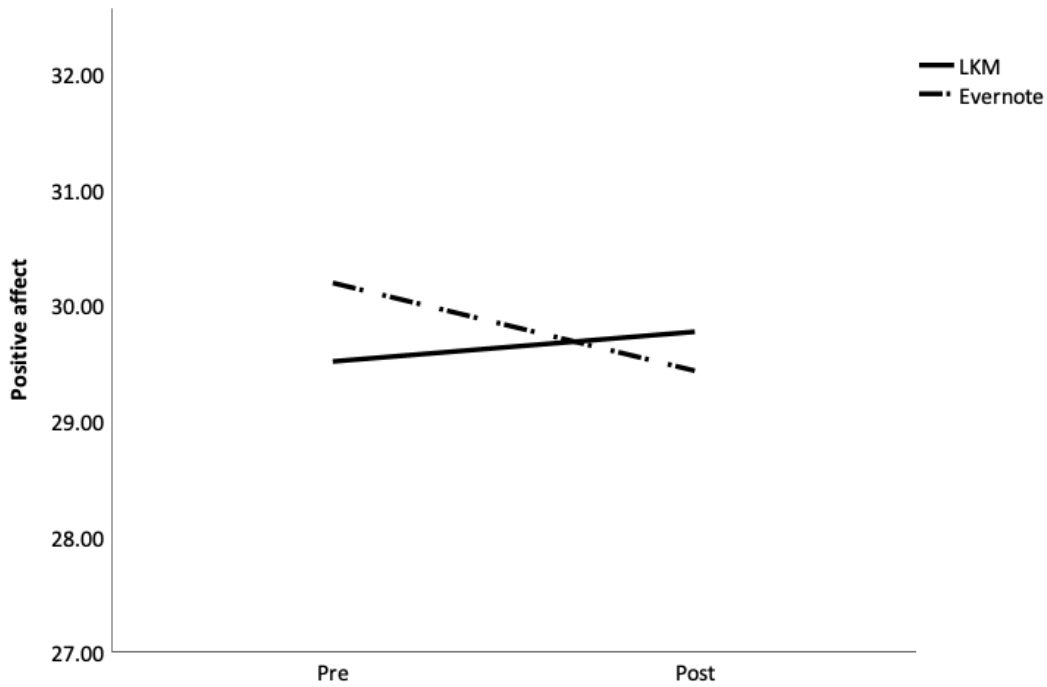


***Positive Affect***

Visual representation of mean positive affect from pre- and post-intervention for both groups are displayed in Figure 5. After adjusting for pre-intervention positive affect, there was no statistically significant difference in change in positive affect between groups,  $F(1, 309) = 2.21, p = .138, \text{partial } \eta^2 = .007$ . Simple contrasts showed that there were no significant differences positive affect from pre- to post-intervention in the LKM condition,  $t(160) = .47, p = .640, d = .04, 95\% \text{ CI } [-.12, .19]$  or in the Evernote condition,  $t(150) = -1.42, p = .157, d = -.17, 95\% \text{ CI } [-.28, .04]$ .

Figure 5

*Means Scores of Positive Affect at Pre- and Post-Intervention for LKM and Evernote Groups*

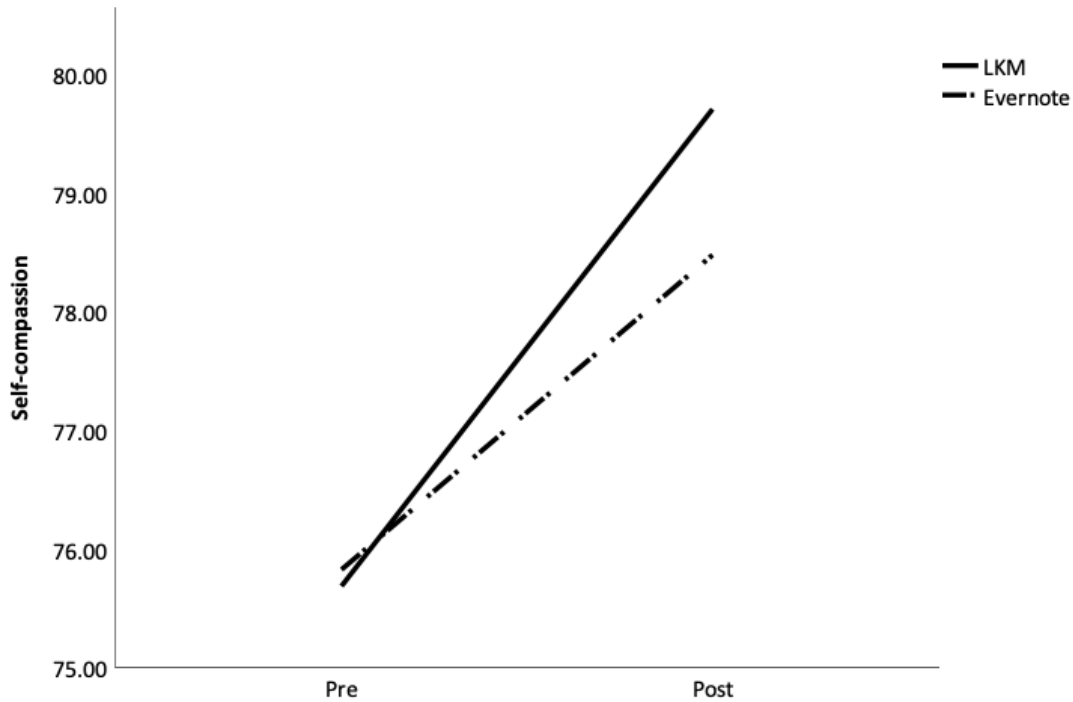


### ***Self-Compassion***

Visual representation of mean scores for self-compassion from pre- and post-intervention for both groups are displayed in Figure 6. After adjusting for pre-intervention self-compassion, there was no statistically significant difference in change in self-compassion between groups,  $F(1, 309) = .831, p = .363, \text{partial } \eta^2 = .003$ . However, simple contrasts showed that there were significant increases in self-compassion from pre- to post-intervention in both the LKM condition,  $t(160) = 3.96, p < .001, d = .31, 95\% \text{ CI } [.15, .47]$  and the Evernote condition,  $t(150) = 3.07, p = .003, d = .25, 95\% \text{ CI } [.09, .41]$ .

Figure 6

*Means Scores of Self-Compassion at Pre- and Post-Intervention for LKM and Evernote Groups*



## Moderation Analyses

### *Mindfulness*

Simple moderation models investigated whether baseline mindfulness moderated the effect of intervention on each outcome variable. Mindfulness was not found to moderate the effect of condition (LKM or Evernote) on the primary outcome, change in depressive symptoms. Specifically, there was no significant interaction between condition and mindfulness,  $b = -.02$ ,  $t(307) = -.47$ ,  $p = .641$  in the moderation model for change in depressive symptoms as an outcome. Similarly, mindfulness was not found to moderate the effect of condition on changes in perceived stress [ $b = -.02$ ,  $t(307) = -.51$ ,  $p = .614$ ], negative affect [ $b = -.001$ ,  $t(307) = -.23$ ,  $p = .816$ ], positive affect [ $b = -.03$ ,  $t(307) = -.73$ ,  $p = .465$ ], or self-compassion [ $b = .08$ ,  $t(307) = 1.12$ ,  $p = .264$ ].

***Fear of Compassion for the Self (FOCS)***

Simple moderation models were then conducted to explore whether baseline FOCS moderated the effect of condition on study outcomes. FOCS was not found to moderate the effect of condition on change in depressive symptoms, given that there was no significant interaction between condition and FOCS,  $b = .05$ ,  $t(307) = .65$ ,  $p = .514$ . Similarly, FOCS was not found to moderate the effect of condition on change in perceived stress [ $b = -.04$ ,  $t(307) = -.84$ ,  $p = .403$ ], negative affect [ $b = -.06$ ,  $t(307) = -1.09$ ,  $p = .276$ ], positive affect [ $b = .001$ ,  $t(307) = .02$ ,  $p = .987$ ], or self-compassion [ $b = -.18$ ,  $t(307) = -1.69$ ,  $p = .09$ ].

***Frequency of App Use (Dose)***

Simple moderation models investigated the frequency of app use during the intervention period moderated each outcome variable between the LKM and Evernote conditions. The frequency of app use (days) was not found to moderate the effect of condition on change in depressive symptoms, given that there was no significant interaction between condition and frequency of app use,  $b = .02$ ,  $t(307) = .04$ ,  $p = .968$ . Similarly, frequency of app use did not moderate the effect of condition on change in perceived stress [ $b = .10$ ,  $t(307) = .33$ ,  $p = .742$ ], negative affect [ $b = .09$ ,  $t(307) = .27$ ,  $p = .790$ ], positive affect [ $b = -.41$ ,  $t(307) = -1.24$ ,  $p = .217$ ], or self-compassion [ $b = .10$ ,  $t(307) = .15$ ,  $p = .880$ ].

**Perceived Usefulness and Impact**

Table 4 provides an overview of participant ratings on the perceived usefulness and impact of their assigned app. Overall, participants in the LKM condition reported that they found the app activity more useful than those in the Evernote condition,  $t(301) = 3.60$ ,  $p < .001$ . Participants in the LKM also reported that the perceived impact on their well-being and/or mental health was more positive than those in the Evernote condition,  $t(301) = 3.35$ ,  $p = .001$ . In

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the LKM condition 73.3% of participants in the LKM reported some positive effects related to using the app, which was significantly greater than 52.3% of those in the Evernote condition (Fisher's Exact test,  $p < .001$ ). There were no significant differences in reported negative effects, with 9.3% of participants in the LKM condition and 13.2% of participants in the Evernote condition reporting some negative effects related to app use (Fisher's Exact test,  $p = .28$ ). Formal qualitative analyses were beyond the scope of the current study, however descriptors of negative effects for both groups are displayed in Appendix B. In terms of self-reported negative effects from 15 participants in the LKM condition, the majority related to feeling annoyed or irritable as a result of timing of surveys, the time it took to complete the activity and surveys, or feeling bored. A few participants wanted more tangible solutions or motivating messages, or felt disappointed that they had not become more mindful or compassionate over the 10-day period. Two participants expressed feeling sad or lonely as they had difficulty identifying a person to bring to mind in during the LKM meditation. Lastly, one participant stated that a personal issue that had been "shoved away" came to the surface.

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**Table 4**

*Post-Intervention Perceived Usefulness and Impact for LKM and Evernote Groups*

	LKM				Evernote				Statistic
	n	%	M	SD	n	%	M	SD	
Usefulness	157		2.59	.83	146		2.23	.88	$t(301) = 3.60, p < .001$
Not at all	12	7.5			33	21.9			
Slightly	63	39.1			56	37.1			
Moderately	61	37.9			47	31.1			
Very	20	12.4			10	6.6			
Extremely	1	.6			0	0			
Missing	4	2.5							
Impact	157		3.59	.62	146		3.36	.61	$t(301) = 3.35, p = .001$
Very negative	0	0			0	0			
Somewhat negative	5	3.1			6	4			
Neutral	60	37.3			86	57			
Somewhat positive	86	53.4			50	33.1			
Very Positive	6	3.7			4	2.6			
Missing	4	2.5							
Positive effects	158				146				Fisher's Exact test, $p < .001$
Yes	118	73.3			79	52.3			
No	40	24.8			67	44.4			
Missing	3	1.9			5	3.3			
Negative effects	157				145				Fisher's Exact test, $p = .28$
Yes	15	9.3			20	13.2			
No	142	88.2			125	82.8			
Missing	4	2.5			6	4			

### **Discussion**

Mental health and well-being benefits related to mindfulness are well documented (Creswell, 2017). While often included in formal MBIs, LKM is a specific type of meditation practice that has demonstrated meaningful mental health benefits in its own right (Hofmann et al., 2015). More recently, interest in harnessing mobile apps to deliver MBIs has grown given the ubiquity of smartphone technology. These apps offer a benefit of reducing barriers to traditional MBIs, such as cost, time demands, and limited access to trained providers (Creswell, 2017; Economides et al., 2018). To date, there is some evidence to support the utility of app-based mindfulness interventions (Gál et al., 2021), and brief app-based mindfulness interventions have been associated with some mental health and well-being benefits (Flett et al., 2019; Sousa et al., 2021). Individuals may begin to explore mindfulness or meditation apps by using them for a brief period of time (Kozlov et al., 2020), yet little is known about how these brief periods of use may impact an individual's mental health and well-being. The present study was the first to explore the efficacy of a 10-day app-based LKM practice on mental health and well-being using an RCT design, and to examine possible moderators of intervention efficacy.

### **Overview of Findings**

Taken together, findings from the current study provide modest support for the use of brief app-based LKM practices to enhance mental health and well-being – particularly for reducing distress – in university students. Compared to an active control group, the LKM intervention significantly reduced some indicators of poorer mental health from pre- to post-intervention, including depressive symptoms, perceived stress, and negative affect. Effect sizes were small for all three of these outcome variables. These findings are consistent with previous studies of brief mindfulness practices that have shown small, but significant, reductions in



negative affectivity (Schumer et al., 2018). In contrast, there was no significant difference in change in positive affect or self-compassion observed between the LKM and control conditions. In relation to the secondary aim, exploratory analyses did not reveal any moderating effects of baseline trait mindfulness, fear of compassion for the self, or frequency of app use on any of the mental health or well-being outcomes. Each of the findings will be discussed in turn below, as well as the clinical implications, study limitations, and future research directions.

### **Depressive Symptoms**

As hypothesized, participants in the LKM condition showed decreases in the primary outcome variable – depressive symptoms – compared to the control condition. The current study is the first, to our knowledge, to demonstrate that, similar to brief app-based mindfulness interventions (e.g., Flett et al., 2019; Howells et al., 2016), brief LKM practices delivered via smartphone apps can reduce depressive symptoms in non-clinical samples. While a clinical sample was not recruited for this study, it is noteworthy that baseline levels of depressive symptoms were in the clinically significant range for both study conditions. This suggests that app-based LKM could also be of value in clinical samples, as an adjunct to established treatments, though further research is needed.

Findings from the current study align with other studies demonstrating that lengthier, in-person LKM interventions are associated with reduced depressive symptoms in both non-clinical and clinical samples (Fredrickson et al., 2008; Hofmann et al., 2015; Shahar et al., 2015). However, not all studies have demonstrated immediate benefits of LKM. For example, a recent study of university students did not find decreased depressive symptoms immediately following a five-week LKM intervention (Totzeck et al., 2020). However, the authors suggested this could have been due to the post-intervention measurement occurring during a particularly stressful time

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of the academic year, and a reduction in depressive symptoms was found at six-month follow-up. A brief, two-session LKM intervention in an undergraduate sample also failed to demonstrate post-treatment reductions in depressive symptoms compared to a control condition (Polizzi et al., 2019). One possible reason for the results put forth by the authors of the study was that they did not standardize the delivery of the home practice. Future research will be important to further understand under what conditions and for whom brief LKM interventions, including app-based LKM, are most effective.

Small effect sizes for reductions in depressive symptoms were found in the current study, whereas medium effects sizes have been identified for reductions in depression in FIM interventions more broadly (Lv et al., 2020). Large effect sizes have been found for lengthier (15-week) in-person LKM interventions in clinical samples (Hofmann et al., 2015). This suggests that more comprehensive, in-person training may provide more robust mental health benefits, though more research is needed.

### **Perceived Stress**

As hypothesized, LKM was associated with reductions in stress compared to the control condition. These findings align with previous brief app-based mindfulness intervention studies in university samples, which have demonstrated reductions in distress following a brief intervention period (Economides et al., 2018; Sousa et al., 2021). Studies of longer LKM interventions have also found some support for reductions in perceived stress (Wallmark et al., 2013; Totzeck et al., 2020). Nonetheless, research regarding the stress-buffering effects of LKM remains somewhat mixed (Galante et al., 2014). The effect size for the current study was relatively small. Larger effects sizes have been found for a longer FIM intervention (eight weeks, with two weeks of

LKM) on perceived stress, again indicating that more comprehensive training may indeed provide more robust changes in outcomes.

### **Negative Affect**

As hypothesized, negative affect was reduced in the LKM condition compared to the control condition. This finding is consistent with other studies that have demonstrated changes in negative affect following LKM inductions (Hutcherson et al., 2008) as well as lengthier LKM intervention periods (e.g., 12 weeks; Hofmann et al., 2015). As with other variables in the current study, the effect size was relatively small. The current findings contrast some previous studies of LKM (Polizzi et al., 2019) and brief app-based mindfulness interventions (Howells et al., 2016), where negative affect was not reduced. It is again unclear what accounts for mixed findings for negative affect within the LKM and MBI literature. It may be related to individual difference variables, where for only some people or under certain conditions does LKM foster a reduction in negative affect. Future research in this area is needed.

### **Positive Affect**

An unexpected finding in the study was that there was no significant change in positive affect between the LKM and control condition. This was surprising given that one of the ways through which LKM has been purported to improve mental health is by bolstering positive emotions (e.g., Fredrickson et al., 2008). The current findings are also in contrast to meta-analytic findings of small to medium effect sizes for LKM interventions on positive emotions (Zeng et al., 2015). However, there are indeed other studies that have not found changes in positive affect following LKM (e.g., Hirshberg et al., 2018).

One potential explanation for the unexpected findings in our study relates to the measure that we used to operationalize positive affect – the PANAS. The PANAS is a commonly used

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instrument and lists the following emotions to produce a score for positive affect: Interested, excited, strong, enthusiastic, proud, alert, inspired, determined, attentive, and active (Watson et al., 1988). This measure focuses on higher arousal states (Harmon-Jones et al., 2016; Mehrabian, 1997). Some studies have indeed found changes in positive affect from LKM using the PANAS (e.g., May et al., 2014). That being said, we may not have adequately captured other positive emotions that could have been enhanced by LKM practice such as love, joy, gratitude, hope, amusement, and awe (e.g., Fredrickson et al., 2008). There is some research to suggest that LKM may foster positive emotions related to feeling peaceful, calm, content, and serene, rather than more active positive emotions such as excitement (Kearney et al., 2014; Koopmann-Holm et al., 2013). Thus, while we did not find changes in relation to the PANAS, given that other types of positive emotions were not adequately captured using the PANAS it is plausible that other positive emotion may have been enhanced in our study (Harmon-Jones et al., 2016). It is also possible that LKM created more transient, daily fluctuations in positive affect that were linked to some of the reductions in distress observed, but that these were either not sustained over time or were not detected using a retrospective (i.e., past week) self-report measure.

Another possible explanation for the unexpected findings is that without enough context for LKM training (e.g., a didactic training, opportunity to process experiences in a group setting), increases in positive affect were not as robust. Some studies have found that without a more significant didactic training period prior to LKM, effect sizes tend to be smaller in terms of increasing positive affect (Zeng et al., 2015).

### **Self-Compassion**

Contrary to our hypothesis, there were no significant differences in changes in self-compassion between groups. Interestingly, both groups seemed to show significant increases in

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self-compassion from pre- to post-intervention. This may have been the result of demand characteristics or expectancy effects after learning that the study explored LKM following the informed consent process. Or, there may have also been an aspect of the Evernote app or another variable that increased self-compassion by chance. As such, we cannot conclude that self-compassion increased specifically as a result of LKM when compared to the control in the current study, though it is indeed possible that the app did have a small effect on self-compassion.

Findings from the current study are in contrast to longer LKM intervention studies that have demonstrated changes in self-compassion post-intervention (Kearney et al., 2013; Shahar et al., 2015). However, findings have been more mixed in terms of brief LKM interventions, with some fostering changes in self-compassion over four sessions (Weibel et al., 2017) and others finding no change in self-compassion with an average of six days of at home practice over two weeks (Polizzi et al., 2019). It is likely that a longer period of engaging in LKM is required to elicit a meaningful shift in how one relates to themselves in terms of self-compassion. Indeed, the MSC program, which has been associated with a host of mental health benefits, including enhanced self-compassion, incorporates LKM as one of many practices and is delivered over an eight-week period with practice assigned for homework (Neff & Germer, 2013). As discussed in relation to other study outcome variables, it is possible that not having enough contextual or didactic information or opportunity to process meditation experiences related to LKM may have resulted in less robust findings. Taken together, it seems that a low-intensity LKM practice without a significant amount of didactic training and offered over a short period of time may not be enough to significantly enhance trait level self-compassion compared to a control condition. However, further research is needed to clarify this finding.

### **Moderators**

A secondary aim of the current study was to explore for whom and under what conditions a brief app-based LKM practice may be most beneficial. To this end, baseline mindfulness, fear of compassion for the self, or frequency of app use were explored as moderators of the effect of treatment condition on any of the mental health or well-being outcomes. Each moderator will be discussed in turn below.

### ***Mindfulness***

Baseline trait mindfulness did not moderate the effect of group on any of the outcome variables. Thus, regardless of one's general capacity to be mindful in daily life there seems to be potential to reduce distress from brief app-based LKM practices. To our knowledge, this is the first study to explore trait mindfulness as a moderator of LKM. In the broader MBI literature, there is mixed evidence to date in the role of trait mindfulness in moderating the effect of MBIs, though this research is limited (Ratcliff et al., 2021; Shapiro et al., 2011; Sousa et al., 2021).

It is also important to consider that trait mindfulness may play a role in who benefits most from LKM, but measurement issues may have precluded finding significant effects in the study. The operationalization of baseline trait mindfulness in the current study was a composite score of four subscales of the FFMQ, without the observe subscale (Cavanagh et al., 2018; Gu et al., 2016). It is important to note that there is no consensus on how to best operationalize mindfulness and there are inherent limitations of self-report for this construct (see Van Dam et al., 2018b). Indeed, there is great debate as to how to best measure mindfulness and disagreement as to the nature of the construct itself, which remains an important area of inquiry (Grossman, 2011; Van Dam, et al., 2018b). It is also possible that, rather than trait mindfulness, it is previous experience with mindfulness practices that is important in terms of increasing

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benefit from LKM, which aligns more closely with Buddhist thought. In the Buddhist tradition, meditation practices are viewed as interdependent and mutually enhancing, and there is experimental evidence to support this (Sears & Kraus, 2009).

### *Fear of Compassion for Self*

Fear of compassion for self was not found to moderate the effect of group on any of the outcome variables. To our knowledge, the current study was the first to explore this moderator in the context of a brief LKM intervention. Importantly, findings from the current study indicate that regardless of level of fear of compassion for self, it is possible to derive benefit in terms of reductions in distress from the brief app-based LKM. That being said, our sample was relatively low in terms of fear of compassion for self and it may be that with a sample with more variability or higher levels fear of compassion for self this may yield different findings. Clinical populations tend to have higher levels of fear of compassion for self (Kirby et al., 2019), thus exploring this moderator in clinical samples is important to further understand the role that this plays in terms of benefiting from LKM.

### *Frequency of App Use*

The frequency of LKM practice across the 10-day study period (i.e., dose) was not found to moderate effects of treatment condition on any of the outcome variables. There has been mixed evidence in terms of dose-response relations in app-based MBI research (e.g., Flett et al., 2019, 2020; Kozlov et al., 2020) as well as with LKM (e.g., Fredrickson et al., 2017; Zeng et al., 2017). In the current study, moderating effects may not have been detected given that we had relatively low variability in the sample. The majority of participants completed close to all intervention days, likely due to that fact that course credit was contingent on level of participation in the study. Future studies with longer periods of app-use and perhaps without

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embedded contingencies would generate more variability in how much a participant practices (e.g., Flett et al., 2019, 2020), and allow for more nuanced investigations of the effects of LKM dose on outcomes. There is also some evidence to suggest that it is not the amount of practice, but rather the quality of the practice that accounts for treatment effects (Zeng et al., 2015). We did not assess quality of practice in our study, though this is an important area of consideration for future research.

### **User Experience**

Overall, participant feedback regarding the perceived usefulness and impact on mental health and well-being was more positive for the LKM condition than the Evernote condition. Most LKM respondents (77%) rated the LKM activity as slightly to moderately useful and 53.4% indicating a somewhat positive impact from LKM. Similarly, nearly three-quarters (73.3%) of participants in the LKM condition reported some positive effects, which was significantly greater than those (52.3%) in the Evernote condition. Taken together, it seems that app-based LKM was a feasible and acceptable option for many of the participants and was indeed viewed as more positive than a placebo. However, these ratings are quite modest and may reflect that meditation practices are not of interest to everyone (Levin et al., 2020). Or, perhaps with more didactic teaching or support in learning the practice LKM may be perceived as more helpful. A total of 15 participants (9.3%) endorsed negative effects from LKM, and the majority were related to irritation or frustration as a result of study issues like the timing of surveys or the time it took to complete the activity and surveys. Other issues related to desiring a different outcome or different type of intervention. For example, some participants wanted more motivating or problem solving approaches to coping with emotion or felt disappointed that they had not become more mindful or compassionate over the 10-day period. Two participants



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expressed difficulty identifying a person to offer loving-kindness, which left them feeling sad or lonely. There was also one participant who reflected that a stressor that had been “shoved away” came to the surface. Indeed, some people may find engaging with LKM challenging (Boellinghaus et al., 2014) and perhaps these responses reflect some of the potential drawbacks of app-based LKM without more didactic teaching or feedback from a meditation teacher to better provide context, normalization, and support in navigating these experiences.

### **Possible Explanations for Reductions in Distress**

While we did not explore mechanisms of action in the current study, there are a number of possible explanations for how LKM acts to reduce depressive symptoms, perceived stress, and negative affect. One possible mechanism may be via improved emotion regulation. Indeed LKM has been associated with reduced rumination, as well as increased acceptance and adjusting (Hofmann et al., 2015). Changes in cognitive distortions is another way that both mindfulness and LKM have been found to offer benefit (Dahl et al., 2015; Sears & Kraus, 2009).

Another possible mechanism that may explain these findings relates to the broaden-and-build theory. While we did not find a significant change in positive affect in our study, we only tapped into a particular set of positive emotions. Thus, it may be that positive emotions such as an increased sense of calm or peace may have played a role in reducing depressive symptoms in our study. Similarly, perhaps an increase in feelings of connectedness fostered a reduction in depressive symptoms.

Another potential explanation may be that meditation fostered increased mindfulness more generally (Hoge et al., 2020). Indeed, LKM has been found to increase state attention following a practice period (May et al., 2011). While precise mechanisms for this again remain unclear within the MBI literature, some studies have shown that mindfulness offers stress-

buffering effects by enhancing self-acceptance (Rodriguez et al., 2015) and non-judging (Querstret et al., 2018). It is possible that in the same way, LKM fosters a shift in perspective (i.e., less judgmental and more accepting) in how one relates to themselves or stresses within their lives.

### **Clinical Implications**

Smartphone apps have emerged as important tools for mental health that are widely available and offer increased access, convenience, reduced cost, and may offer unique benefits to those may not want to seek traditional mental health services due to stigma (Linardon et al., 2019). Findings from the present study offer support related to the potential utility of app-based LKM practices to reduce distress among a non-clinical sample of university students. Rates of psychological distress and depression are well-documented in this population (Twenge et al., 2019). Importantly, negative affect often predicts potential for clinical symptomatology (Schumer et al., 2018). As such, utilizing app-based LKM may offer an effective, low-threshold approach for improving mental health and well-being in those who are at risk for developing further mental health issues, particularly related to negative affect, stress, and low mood. For example, app-based practices may offer some potential utility for those on waitlists for more intensive services (e.g., university counselling centres; Flett et al., 2020; Levin et al., 2020).

Coupled with previous findings that LKM is particularly beneficial for reducing depressive symptomatology among clinical samples (Hofmann et al., 2015), our results also lend some support for brief app-based LKM practices to be further explored as an adjunct to traditional evidence-based therapies for depression. While our sample was not a clinical one, 54% of the total sample exhibited clinically significant, albeit mild, depressive symptoms. Indeed, there is already evidence to support mindfulness-based therapeutic approaches for

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depression (e.g., MBCT; Segal et al., 2002). In terms of LKM more specifically, some authors have discussed the unique role of LKM in psychotherapy (e.g., Shonin et al., 2014), and the possible benefits of including practices such as LKM in CBT protocols for depression (e.g., Frick et al., 2020; Stefan & Hofmann, 2019). A recent study protocol was published for a metta-based group meditation and individual CBT (MeCBT) treatment program for individuals with persistent depressive disorder, which will yield important findings in this regard (Frick et al., 2020). While not intended to replace professional mental health support for depression, smartphone apps have shown promise as adjuncts to treatment (Linardon et al., 2019).

### **Study Limitations**

There are a number of limitations of the current study that warrant discussion. First, while a brief descriptor of LKM was provided during randomization, comprehensive training related to LKM practice was not offered. While this was intentional – to more closely mirror how many people first explore these practices through smartphone apps – it may have resulted in less benefit from the LKM practice (Zeng et al., 2015). It is likely that providing didactic training as well as an opportunity for inquiry or reflection on meditation practice (Segal et al., 2002) is an important part of maximizing benefits from LKM, and that a more structured, guided intervention would facilitate enhanced outcomes. It is also possible that LKM may offer significantly greater benefit when practiced in a more traditional, spiritual context, given that the nature of the practice is grounded in Buddhist concepts and philosophy. However, our study does provide evidence that even alone, in an arguably “out of context” and secular situation, there is still some benefit to LKM practice.

While our findings lend support for more immediate improvements in mental health and well-being outcomes (i.e., post-intervention) from LKM, we did not assess the stability of these

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changes over time. Ten days is a relatively short period of time for assessment, and thus the full emergence of possible benefits from the practice may not have been observed. On the other hand, it is unclear whether the benefits observed were sustained over time. Future studies exploring the longitudinal benefits of using an app-based LKM practice seems warranted to determine both short and longer term effects on mental health and well-being.

Another limitation relates to reliance on self-report to verify daily LKM practice. While we utilized a daily measure of adherence, it was difficult to determine whether participant actually completed their assigned task. Similarly, it was difficult to determine whether participants were fully engaged in the practice, or if they were distracted by other things in their surroundings or multi-tasking. Importantly, quality of practice tends to be associated with improved outcomes (Zeng et al., 2015). Future research may benefit from collecting objective measures related to app use (i.e., use data collected via app platform) to ensure adherence to study protocols (e.g., Flett et al., 2020). In terms of examining engagement in practice, utilizing brief qualitative reflection (Grossman, 2011) or quantitative measures of experience during meditation (e.g., Reavley & Pallant, 2009) may be of benefit.

A limitation to the generalizability of the results relates to the sample of the study. We used a convenience sample of non-clinical undergraduate students, thus current findings do not necessarily generalize to adult community or clinical samples. However, given the mental health and well-being benefits of LKM in clinical populations (e.g., Hofmann et al., 2015), it is seems warranted to further the benefits of app-based LKM in other populations and as an adjunct in to more comprehensive treatment in clinical samples. Similar to other studies utilizing a university student participant pool, there were a greater number of female participants of white/Caucasian

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ethnicity, thus our findings may not accurately represent experiences of more diverse populations and future research to address this will be important.

While we had a relatively large sample size compared to similar studies investigating brief app-based interventions, we may not have had enough power to detect moderation effects. As discussed above, we also had relatively low variability in moderator variables such as frequency of app use and participants were relatively low on fear of compassion for self, making it even more difficult to detect these moderation effects.

Lastly, it is unclear how the emergence of the COVID-19 pandemic may have impacted results. There were 47 participants (15.1%) in the current study who completed the study during the emergence of the pandemic. Unfortunately, there was not enough power to explore whether there was a difference in intervention effects between pre- and post- pandemic participants. It is possible that LKM may have offered some additional benefit to participants during the emergence of the pandemic in terms of dealing with the stressor. However, it is also possible that study outcomes were affected negatively (e.g., increased levels of stress or low mood), which may have resulted in reduced effect sizes from the intervention.

### **Future Directions**

Given that LKM research is in its infancy within the Western psychological literature, there are a number of exciting future directions to build on findings from the current study. The issue of dosage remains a primary area of inquiry in the MBI literature (Davidson & Dahl, 2018). In the current study, we were limited in exploring the moderating role of dose, or frequency of app use, due to relatively high adherence. Future app-based studies over a longer period of time with both prescribed and discretionary app use (e.g., Flett et al., 2019) may yield important findings regarding how often app-based LKM needs to be practiced to foster mental health and

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well-being benefits. Other dosage questions, such as whether it is more effective to engage in one longer practice or multiple brief sessions in a day, or whether retreats or intensive programs provide more benefit than daily practice remain unanswered (Davidson & Dahl, 2018). Quality of meditation practice is also an important factor to consider and address in future research (Zeng et al., 2015). Further, future research exploring the stability of mental health and well-being benefits, both immediate and longer-term impacts, from various doses of practice will be important to further our understanding of app-based LKM and other meditation practices.

Another avenue of important research relates to examining the role of didactic training and context or support provided for LKM training. Some studies have found that less benefit is garnered without a more significant didactic training period prior to LKM (Zeng et al., 2015). This makes sense from the Buddhist perspective as well, where these practices are contained in a comprehensive training and philosophical context (Davidson & Dahl, 2018). Future studies should test the role of didactic learning in app-based practices. Another important focus of research is to explore the mutually enhancing benefits of Buddhist-derived meditation practices, which again aligns with the Buddhist perspective. For example, greater benefit has been found for combined mindfulness and LKM than either practice alone (Sears & Kraus, 2009). Indeed, understanding their unique mechanisms and benefits is important, but equally of value is understanding the combined impacts of these practices. In terms of application to app-based meditation, future research should compare more structured app-based programs that incorporate various types of meditation practices (e.g., mindfulness, LKM, and other FIMs) with psychoeducational content compared to more naturalistic self-directed use of different meditation practices.

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Another key direction for future research is exploring mental health and well-being benefits of app-based LKM in other populations such as a community sample, more diverse samples (e.g., age, gender, ethnicity), and clinical populations. Indeed, studies of community adults have shown larger effects from brief mindfulness interventions (Schumer et al., 2018), thus exploring brief LKM in community samples is an important area for further study. As discussed above, exploring app-based LKM use in clinical populations, possibly as adjuncts or augmentation to other evidence-based treatment approaches is an exciting next direction. LKM has indeed shown benefit in some clinical populations (Graser & Stangier, 2018). Exploring the benefits in app-based practices, both for people with depression but also other clinical conditions (e.g., anxiety disorders), may offer clinicians evidence-based and cost-effective adjunct tools to recommend to their clients.

Importantly, LKM and other meditation practices should not be viewed as a panacea (Van Dam et al., 2018a). As with other MBIs, LKM may be offer benefit or be appropriate for some people and not for others (Davidson & Dahl, 2018). There is a dearth of research in this area and future research should continue to explore individual differences in the context of LKM. For example, fear of compassion for self could be explored as a moderator in app-based LKM in clinical populations. Importantly, it is unclear whether there are contraindications for LKM, particularly in sub-clinical and clinical samples, and future research should document any adverse events to further understand possible risks or populations that may need more robust support when utilizing this practice, especially in an app-based format (Van Dam et al., 2018b).

Exploring mechanisms through which LKM offers mental health and well-being benefits is another important area of inquiry. Indeed, as described previously, there is support for the generation of positive affect as a key mechanism in LKM (Engen & Singer, 2016; Zeng et al.,

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2015). Future research exploring which positive emotions are most salient in LKM will be one vital avenue of research. Studies investigating a broader range of positive emotions, including ones related to unactivated positive emotions (e.g., peaceful, serene, calm) or prosocial emotions would likely yield important findings. More research is also needed to explore the role of emotion regulation in LKM. There is a dearth of research in this area, however some initial evidence points to reduced rumination, and increased acceptance of emotions and ability to modulate or balance emotions (adjust) have some initial support (Hofmann et al., 2015). These have not been tested in app-based LKM or brief LKM interventions more generally. Cognitive reappraisal has been proposed as a mechanism through which LKM may operate, but again there is limited research in this area and this warrants attention in future research (Dahl et al., 2015; Sears & Kraus, 2009). Other avenues to explore with respect to mechanisms in LKM practice include perspective taking (Dahl et al., 2015) and prosocial motivation and other social processes (Engen & Singer, 2016). Daily diary methods in app-based LKM may offer further insight in to the roles of various mechanisms in LKM.

Lastly, continued discourse between Western psychological and medical science, neuroscience, and Buddhist scholars remains essential to explore the benefits and drawbacks of modern secularization of Buddhist meditation practices (Purser et al., 2016). Given that these practices were not originally intended to be therapeutic tools, it is imperative to consider the impact of, and acknowledge the limitations, that come from isolating these practices from the broader spiritual, philosophical, historical, and cultural context from which they originated (Davidson & Dahl, 2018). Indeed, there are impactful mental health and well-being from secular Buddhist-derived meditation practices (Creswell, 2017) and this research continues to be an exciting and important area of inquiry.



### **Conclusion**

The current study demonstrated, for the first time, that a relatively brief, daily LKM practice delivered via a smartphone app has benefit for reducing distress, specifically depressive symptoms, perceived stress, and negative affect in a non-clinical sample of university students. Free app-based platforms allow for broader reach of these practices to those who may not otherwise access services, and thus are an important tool to enhance mental health and well-being. Findings from this study suggest that clinicians may want to consider utilizing brief, LKM practices to augment other therapeutic approaches to reduce negative affectivity, though future research is needed in broader non-clinical and clinical populations.

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## **Appendix A: Condition Scripts**

### **Condition 1: LKM Script**

Loving-kindness meditation is a practice that focuses on directing positive feelings and kind concern towards yourself and others. It is both a practice and a quality that can be cultivated. For example, typically when you practice loving-kindness meditation, you're sharpening your ability to relate to yourself and others more kindly and compassionately both in that moment, and also after you've finished meditating. By practicing loving-kindness meditation people have reported increased well-being. However, like any skill it becomes easier with practice, which is why daily practice is needed.

For this task you will be using the app you downloaded called Insight Timer. You will be asked to do the loving-kindness meditation practice daily for 10 days in a row. This activity is about 9 minutes in length. It is very important that you only do this meditation for the duration of the study, and don't use other parts of the app until the study is complete. For the duration of your participation in the study, it is also requested that you refrain from using other meditation or mindfulness apps (e.g., Headspace, Calm).

It's important that you do this practice every day for the 10 days. Please make sure that you do your app activity in a place with no distractions where you can really focus on the task (e.g., quiet, not in front of tv). It is helpful to think about a time that might be ideal for you to do this exercise, for example right after breakfast or sitting in the car in the parking lot. You can also set an alarm in your phone. What do you think would be helpful for you to remember to complete it? (let each person answer).

At 8pm each day, you will receive a reminder to complete your exercise. Then, at 9pm you will receive a brief questionnaire via the MetricWire app that you downloaded. Please

## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

complete this as soon as you receive it – it is short and should take less than 3 minutes. Once the 10 days of app use are complete, you will receive a follow-up survey to complete via email.

Please complete this as soon as you receive it. Your SONA credits will be given once you have completed the 10 day follow-up survey, however if you choose to withdraw at any time your credits will be pro-rated. If you are interested in the extended study, you will continue to use the same loving-kindness practice at your leisure. You will receive a follow-up survey in 30 days.

Once you have completed that survey, you will receive a \$5 Starbucks card.

### **Condition 2: Organisational Reminiscing Script**

Organisational Reminiscing (O.R.) is the practice of paying attention to past behaviours, experiences, and activities in a particular way; on purpose and with awareness of the self. For example, typically when you practice O.R., you're sharpening your focus and training your brain to be more reminiscent long after you've finished engaging in O.R.. By practicing O.R. people have reported increased well-being. However, like any skill it becomes easier with practice, which is why daily practice is needed.

For this task you will be using an app called Evernote. You will be asked to set a timer for 9 minutes for this activity. You will then use the app to jot down all the things you can remember doing on this day last week in a checklist format. For example, on a Monday you would jot down all of things you can recall doing on the previous Monday. For the duration of your participation in the study, it is requested that you **refrain from using other meditation or mindfulness apps (e.g., Headspace, Calm).**

It's important that you do your O.R. practice every day for the 10 days. Please make sure that you do your app activity in a place with no distractions where you can really focus on the task (e.g., quiet, not in front of tv). It is helpful to think about a time that might be ideal for you to do this exercise, for example right after breakfast or sitting in the car in the parking lot. You can also set an alarm in your phone. What do you think would be helpful for you to remember to complete it? *(let each person answer).*

At 8pm each day you will receive a reminder to complete your exercise. Then, at 9pm you will receive a brief questionnaire via the MetricWire app that you downloaded. Please complete this as soon as you receive it – it is short and should take less than 3 minutes. Once the 10 days of app use are complete, you will receive a follow-up survey to complete via email.

## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

Please complete this as soon as you receive it. Your SONA credits will be given once you have completed the 10 day follow-up survey, however if you choose to withdraw at any time your credits will be pro-rated.

If you are interested in the extended study, you will continue to use the same O.R. practice at your leisure. You will receive a follow-up survey in 30 days. Once you have completed that survey, you will receive a \$5 Starbucks card.



**Appendix B**

*Participant descriptions of reported negative effects from interventions*

<b>LKM</b>
A little bit of annoyance maybe, because of the pressure to get it done and do all of the surveys.
Even though my body was at ease. I didn't feel like my mind was at ease afterwards.
Have to wait till 9 to finished the daily assignment Since I am an early bird who usually sleep earlier and wake up earlier this app activity distracted my sleeping schedule.
Her voice made me irritable at times. I didn't like how it almost tried to encourage me to wallow in my feelings and just be an emotional puddle, without really suggesting solutions. I wish it was a bit more empowering and motivating.
I became more irritable and easily angered.
I found that I was more stressed as I was spending time on this rather than being productive on the things stressing me out
I knew before I started that I wasn't a very mindful person so I wasn't expecting to be fully engaged or feel lots of love/compassion right away, but it was slightly disheartening to see that I wasn't able to accomplish this by the end of the study period.
The way she spoke and what she said — it made me look into myself and I didn't really enjoy that because I have personal thing I shoved away because I didn't want to deal with it. And the audio started to bring them to the surface.
I was simply or bored or put to sleep by the recording sometimes. It made me anxious or irritable to have to sit down and listen to something that felt pointless everyday.
I would get sad thinking about live and kindness or looking for an individual that made me happy. It was hard because I felt like there wasn't really anyone.
It made me realize that I didn't have many people around me that I can immediately bring to mind that make me happy or feel a certain way. Especially with everything going on in the world everyone is distancing themselves from one another it kind of made me feel lonely and sad and start looking into some of my friendships with people.
The last few days were frustrating and I often found it hard to focus on the meditation because I didn't want to be doing it anymore.
The survey came out quite late and I usually go to bed before 9pm so I had to stay up to do the survey even though I would complete the activity in the morning.

## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

The voice of the guided meditation got very annoying after listening to it for 10 days in a row.

There were days that I almost forgot to do the meditation, due to working all day or having classes throughout the day / evening. It put a little added stress on me once I did remember and felt pressure to complete it.

### **Evernote**

After a while it became tedious for me to take notes about my past week, therefore I became a bit agitated with the app.

Annoyed by the notification.

Got very bored and didn't know what to write.

I already have a habit of thinking about myself in the past and overthink things. Doing the activities increase those habits because I was forced to try to remember what I have done in the past. It also makes me think of myself more negatively than positive. I don't tend to focus on what I have accomplished, but I tend to dwell on why I seem to accomplish so little. I also overthink of why I seem to not be doing much in my life or be as productive as I expect myself to be.

I didn't find recalling the previous events of the week before calming. I often had trouble thinking of what I did and then it caused me to lose focus. A calming game would make me focus more than recalling past events.

I felt as though it was redundant. The app itself was okay but sometimes I was irritated because I had other things to be doing.

I felt negative about myself for not doing it, or making the decision not to do it when I said I would.

I felt that because I was using the app for a research study that the app was a burden and I did not have the freedom to choose if I wanted to take that time to dedicate to writing about my day.

I felt negative about myself for not doing it, or making the decision not to do it when I said I would.

I just felt more irritable and everything was annoying me easily.

Irritated me having to answer the same questions and have to try to think back even though I couldn't remember.

It felt like a chore that I had to complete before bed. It did not feel beneficial to my mental

## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

well-being.
Just having to recall sad events that happened the previous week.
Just took time and sometimes I would forget or not have it..
Negative events that occurred were reflected on and often brought back similar negative emotions.
Overthinking a lot.
Remind my some embarrassed moment.
Things have been crazy this week and comparing it to last week, it made me sad.
When recalling activities that I had done a week ago it made me realize that all I focus on is studying. I did not meet up with many friends and it made me feel lonely.
While remembering the negative things that happened I would get a sense of sadness and loneliness.

**Appendix C**

*Participant descriptions of reported positive effects from interventions*

<b>LKM</b>
A positive takeaway for me is that I think I understand meditation now, or at least for myself. I like the idea of just sitting and relaxing and taking awhile to just think and I believe it just sets you up for a good day.
After using app felt relaxed
After using the app, some days I would feel more calm after and would feel more mindful of my emotions and how irritable I have been towards others, so it made me much more aware of my headspace and to just take 10 mins to just relax and breathe.
Because my life is so busy, forcing myself to just lay down in a comfortable position without staring at my phone made my body feel very relaxed and made my head feel a bit more clear. I felt more present in the moment and was more aware that I was alive, and not just automatically rushing through every day.
Better containment of my thoughts, I felt less stress and felt in control of my emotions.
Calm
Calmed me down and took my head off schoolwork/problems in my life.
Calmer and centered. Helped me process my feelings.
Dedicating time to it made me feel more appreciative and loving towards myself when I usually wouldn't have consciously thought it or said it out loud.
Directly after using the app my body felt at ease.
During the activity I was able to take a moment for myself and let all of my negative thoughts go away. Even with stress from exams and school, I felt much more relaxed and I was able to forget the stress for the time being.
Feeling happy.
Feeling of being relaxed after using the app.
Felt good about myself and my relationships.
Felt less stressed after doing the session.

## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

Felt like I had alleviated pressure from stress and anxiety.
Felt more optimistic immediately following the daily activity.
Felt more relaxed after.
Felt peaceful during meditation.
Felt slightly more relaxed and helped me fall asleep.
Found myself happier and more reflective of my emotions.
Generally, I think I felt more positive this past week and more inclined to be a little easy on myself.
Good attitude in the morning!
Happy when thinking about a loved one, and feeling compassion for myself.
Have a new perspective on some emotions I was experiencing the first couple days of doing it.
Have time to rest and get along personally.
Having a chance to relax.
Help my anxiety.
Helped me find some self-awareness.
Helped me to take a step back from school work.
I did it before bed so it helped me sleep a bit better I think.
I don't get nervous easily.
I enjoyed taking time to myself to be engaged with my emotions for 9 minutes a day.
I feel like this app really allows me to be more forgiving, loving and kind to other people and especially myself! Although the audio was repetitive, I liked the change in perspective, especially since I felt that I was not really a compassionate person towards myself.
I feel lots of sense of security after every meditation.
I felt a little calmer than I found myself before.

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I felt better after using the app. It didn't last too long, but it helped a little.
I felt better and was able to recall things easier.
I felt calmer afterwards and ready to get back to my day instead of being stressed out the whole day.
I felt I was more reflective on myself and life than usual.
I felt more calm.
I felt more calm and level headed after using the app.
I felt more forgiving of my own flaws and to not take myself so seriously.
I felt overly much happier in my day to day activities.
I found myself feeling more relaxed and focused after I completed the activity.
I got to relax and think about my loved ones and myself.
I just felt extremely relaxed.
I just felt that I was more active in bringing my outlook on everyday to be more positive. However, this past week was approaching reading week break and was after most of my exams, therefore my mood was also naturally improved by having more time to dedicate to my personal interests.
I think I felt more relaxed after meditating sessions.
I think it was easier for me to put myself in someone else's shoes.
I was able to self reflect and understand my emotions.
I would feel more relieved and stress-free after using the app.
Immediately after using the app, I would feel more calm and relaxed.
It forced me to take time out of my day to relax.
It gave me a time to relax.
It helped collect my thoughts, focus on relaxation and calming techniques and helped decrease thoughts of present worries and stress.

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It helped me clear my head a little.
It helped me feel connected with other people even though we are all self isolating.
It helped me remember those around me and focus on the positive aspects of things.
It made me feel relaxed.
It made me want to get deeper into my emotions and address the feelings within myself that I've been to scared to deal with.
It taught me to like myself more.
It was a good way to just relax and let my mind be still. It helped me be more mindful throughout the day of what I'm feeling and why I'm feeling it.
It's easier to express my appreciation to my loved ones.
Its calming.
Just calm and when you listen all. Your thoughts are channeled into something close to you.
Made me more calm sometimes.
Meditating before bed made me sleep better, and I feel like it made me want to be more connected with my family.
More calm.
More focused on loving kindness.
Sense of relaxation, reminded myself to take a little time to be nice to myself.
Slightly better mood towards the end.
Taking the time to think of people or pets that made me happy did put in a more positive head space.
Temporary relaxation when listening to the tape.
The effect of the app was neutral for me. It allowed me to take time out to reflect.
The first few days, it often helped me feel slightly more calm and collected.

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Thoughts cleared my mind and was only thinking about the words of the activity.
Using the app helped me start the day on a more positive note since we were asked to send loving kindness to our loved ones.
Using the app made me feel closer to loved ones.
Very calm shortly after.
While maybe this kind of meditation wasn't right for me, it made me realize how truly difficult it is for me to unwind and be present, which makes me more likely to try other relaxation or mindfulness activities in the future because I really this is something I think would benefit me.
Yes, the couple times I missed doing the survey even though I had done the meditation that day, I felt guilty and a little disappointed in myself.

<b>Evernote</b>
As mentioned above, I was able to reflect on my feelings & through that I realized when I'm not active I'm usually grumpy.
Becoming more aware of my feelings and how certain aspects of my day make me feel.
Calming effect
Easier to forgive people.
Feel more meaningful.
Felt a sense of calm, good study break, put my life into perspective that I was really productive with my days.
Felt more and more calm every day writing what I did in the past week and was able to remember more every day.
Felt more positive about my previous days when looking back, looked at the more positively or detached.
Felt relaxed afterwards.
Forcing me to recount my days and think of all the things that happened that made me happy.
Happier.
I could vaguely remember what I had input the day prior on how I was feeling and so I was



## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

able to compare a bit of my moods. Shows that every day is different and that's ok.
I feel like my ability to remember past events is slightly better.
I feel like this week I paid more attention to what I was doing so that next week I would be able to recall.
I felt like I understood my feelings better.
I felt more contempt with what I'm feeling on a day to day basis.
I felt more euphoric, and generally happier. I enjoyed being able to sit down and think about how and why I feel the way I do, while feeling like I'm participating in something other than browsing media. Overall I feel more well-rounded and content.
I felt more relaxed. It was nice to have time to focus on something like this and challenge yourself to remember last week.
I felt more self-reflective and in control.
I focus more on the positive activities I did recently and forget about any negative ones.
I found as the week went on, I had an easier time focusing on recalling events from the previous week.
I found myself being more thoughtful about how productive I am in a day.
I started to feel less irritable after reflecting upon my previous weeks because I think I was becoming more self aware of my emotions from the past.
I think again it was a good self-reflection from what happened during the day and how I could have improved it but also what were the good moments.
I thought it was a fun thing to do in order to recall what I had done in the previous week. It never hinted towards any negative thoughts from doing it.
I tried to stay positive if I had hard time the day before.
I was able to better process some of the things that happened by putting my emotions to words that were described. I also could learn more about my views on myself by being asked questions such as these ones.
I was able to reflect on my days and what I do in a more positive perspective.
I was able to understand where I had been putting my efforts and time into. I would feel a small sense of pride if i had a productive day because I could see all the tasks I

## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

completed in that day.
I'm glad I got to write down my experiences into words so that I can look back on them later.
It allows me to think of how I'm acting and responding more, allowing me to react better in certain situations.
It gave me 9 minutes just to focus on myself rather than what was going on around me, and it just felt good to look back on my week to see what I was doing.
It gave me a time to think about things happened, which I did not experience because I tended to get over with things and continuously move on to next thing before using the app.
It helped calm me a bit.
It helped me to look back and let me think of what I should start showing an improvement on my behaviors.
It made me feel calm to reflect on my week and what I accomplished each day.
It put me in a better mood when I reflected on my previous week.
It was a nice break from studying each night.
It was positive to think about how I acted or felt the week before and motivated me to make things better this week (if at all possible).
It's a nice break from my routine to reflect on what happened today.
Kinda calming sensation and it's nice to be reminded of what you've accomplished in recent times.
Like I said, thinking more about my negative emotions like loneliness and how much I dwell on my negative thoughts in turn made me dwell on them more. I think it might of made it worse. I'm the loneliest I've felt in months.
Made me feel like I was improving my memory by taking notes on my recent past experiences.
Made me realize on the days where I was more spontaneous and did things I was more happy.
Made me think about my day of the past week and I got to see how happy I was and not look at the negative part so much.
Motivated with positive memory being more positively empowered through reappraisal.
No negatives, but found myself writing the same thing most of the time.

## A BRIEF APP-BASED LOVING-KINDNESS MEDITATION

Self-reflection
Taking more time to slow down and reflect.
The app allowed for me to think and rationalize why I was feeling the way I was and what those feelings meant.
The daily surveys made me more cognizant of my emotions and I noticed myself feeling certain ways.
Thinking about fun moments brought back positive emotions and made me feel good just thinking about them.
Thinking about my friends.
When someone did something I didn't like, this activity gave me a chance to think about the good memories and the happy things we did together.
While remembering the good events of the day a sense of happiness would rush over me.