Journal of Technology in Behavioral Science
https://doi.org/10.1007/s41347-022-00274-2

Assessing the Effectiveness and Utility of a Mindfulness-Based Ecological Momentary Intervention in College Students

Jeffrey M. Pavlacic[1,2] · **Stefan E. Schulenberg**[1,2] · **Sara M. Witcraft**[1,3] · **Erin M. Buchanan**[4]

Received: 2 March 2022 / Revised: 28 July 2022 / Accepted: 12 August 2022

Abstract

Mental health problems are common in college students and yield poor functional outcomes. Despite these emotional and functional difficulties, only a small percentage of students seek treatment due to barriers such as stigma and lack of resources. College students also prefer Web-based services to in-person services; thus, mobile health interventions may be a favored, viable, and accessible option. Ecological momentary interventions (EMIs) incorporate technology to administer interventions and are widely and effectively applied for heterogeneous psychological problems. Mindfulness-based interventions ameliorate psychological distress and promote psychological well-being in college students. Therefore, the current study examined the effectiveness and perceived utility of an EMI incorporating mindfulness-based messages. Participants were 161 undergraduate students (70.19% female; 80.75% white) randomized to either a mindfulness-based EMI or mood monitoring condition (i.e., ecological momentary assessment (EMA)) for 21 days (2812 daily surveys). Contrary to expectations, the EMA condition did not show different outcomes from the EMI condition. Higher engagement in the mindfulness activities was related to higher levels of positive affect, and participants who reported being more aware of emotions (i.e., thoughts, feelings, and behaviors) due to the messages reported lower emotion dysregulation. More emotional awareness due to the mindfulness messages was related to greater usage of messages and a higher likelihood of recommending skills to a friend, and those reporting increased usage of mindfulness messages were more likely to recommend mindfulness skills to a friend. Participants found the mindfulness messages useful and helpful on average. Implications for research and designing of EMIs are discussed.

Keywords College students · Mindfulness · Ecological momentary intervention · Multilevel models

The transition to college is a major adjustment from adolescence to emerging adulthood. Approximately one in five college students meets diagnostic criteria for certain 12-month *Diagnostic and Statistical Manual-Fourth Edition* (*DSM-IV-TR*) disorders (Auerbach et al., 2016). Additionally, psychological distress in college is associated with poor functional outcomes, including lower academic achievement (Olmstead et al., 2016) and decreased social support (Alsubaie et al., 2019), among other outcomes. Despite these negative outcomes, only approximately 16.4% of students with mental health disorders receive "minimally adequate" treatment for mental health concerns (Auerbach et al., 2016).

Several barriers may contribute to low mental health treatment seeking rates among students. Gender differences in societal expectations of emotional expression and help-seeking behavior are relevant to consider (Ennis et al., 2019; Kuhlman et al., 2019; Tang et al., 2014). Perceived stigma (Jennings et al., 2017) and coping strategies (e.g., a lack of emotional openness; Komiya et al., 2000) may also contribute to low treatment seeking rates. Cost of treatment (Givens & Tijua, 2002) could also prevent students from receiving services. In light of these barriers, there is a need for accessible evidence-based interventions for a wide range of college students experiencing psychological distress.

✉ Jeffrey M. Pavlacic
jpavlaci@go.olemiss.edu

[1] Department of Psychology, University of Mississippi, University, MS 38677, USA

[2] Clinical-Disaster Research Center, University of Mississippi, University, MS 38677, USA

[3] Department of Psychiatry and Behavioral Sciences, Medical University of South Carolina, Charleston, SC, USA

[4] Analytics, Harrisburg University of Science and Technology, Harrisburg, PA, USA

Published online: 02 September 2022

One solution to improving college students' access to mental health services is using technology-based interventions. College students request online self-help services to self-monitor and improve mental health when given the option between online self-help and in-person therapy options (Levin et al., 2018), suggesting that technology-based interventions may be a viable solution to improve access to care. Smartphone-based ecological momentary interventions (EMIs), one type of technology-driven intervention, allow for administration of psychological treatments coupled with data collection methods in naturalistic environments (see Shiffman et al., 2008, for an overview). As such, EMIs allow for an understanding of between- and within-person differences in psychological constructs over time and how these differences relate to environmental changes or interventions (Finkelstein-Fox et al., 2020; Pavlacic et al., 2021). Meta-analytic and systematic reviews suggest that EMIs are acceptable (Heron & Smyth, 2010) and improve mental health (Versluis et al., 2016). The largest effects for EMIs occur when EMIs are supported by mental health professionals (i.e., medium to large effect size), followed by standalone EMIs (i.e., small to medium effect size) and then EMIs with access to care as usual (i.e., small effect size; Versluis et al., 2016). Thus, while strongest effects occur when EMIs are paired with other components of treatment protocols or support from mental health professionals, and the evidence of EMIs administered as standalone interventions is not as robust (Heron & Smyth, 2010), EMIs offer a unique and potentially useful way to disseminate evidence-based techniques to college students who may not seek or have access to in-person treatment.

Another consideration is use of transdiagnostic interventions, which may be prudent given the myriad emotional and behavioral difficulties experienced by college students. Transdiagnostic approaches concurrently target multiple presenting problems by addressing underlying psychological maintenance factors (e.g., emotion dysregulation, negative affect, lack of emotional awareness; Levin et al., 2014; Sakiris & Berle, 2019). That is, transdiagnostic approaches can address both comorbidities and what would traditionally be considered subclinical presentations.

Mindfulness has been integrated in heterogeneous intervention approaches and is one transdiagnostic procedure with a developing evidence base for the treatment of emotional difficulties, substance use disorders, and chronic pain (Bamber & Morpeth, 2019; Byrne et al., 2019; Greeson et al., 2014; Hilton et al., 2017). Mindfulness can be operationally defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). Emotion regulation (i.e., the ability to effectively manage emotional activation and responding) is the hypothesized mechanism through which mindfulness exerts these effects (Gratz & Tull, 2010). In college students, mindfulness-based interventions are both feasible and effective in reducing psychological distress (Bamber & Morpeth, 2019; Taylor et al., 2014) and improving psychological health (Bergen-Cico et al., 2013).

Given their potential for adaptation and dissemination, mindfulness techniques and interventions have been infused in technology-driven interventions (e.g., Lucas-Thompson et al., 2019, 2020; Trub & Starks, 2017). Using technology-based mindfulness interventions, users experience reductions in stress, risky behavior, and physiological indices of stress reactivity (e.g., cortisol, systolic blood pressure reactivity; Gluck & Maercker, 2011; Lindsay et al., 2018; Trub & Starks, 2017). Text message-based interventions could potentially provide a more readily accessible way to efficiently disseminate evidence-based services to college students who may not otherwise have the opportunity, capability, or motivation to access more traditional mental health services.

Additionally, given that dosing for mindfulness-based interventions varies (Morton et al., 2020) and is not fully understood (Bambacus & Conley, 2021), it is imperative to examine the effectiveness and utility of technology-driven interventions at varying doses to identify dose–response relationships. In empirical studies, higher home engagement in mindfulness meditation is related to improved psychological outcomes (Crane et al., 2014), a finding also supported in meta-analytic reviews (Parsons et al., 2017) and Web-based mindfulness interventions (Gluck & Maercker, 2011). However, in meta-regression results assessing dose–response relationships in mindfulness-based programs, larger doses of mindfulness-based programs do not predict psychological outcomes despite predicting higher levels of mindfulness (Strohmaier, 2020). Accordingly, it would be useful to understand whether level of engagement interacts with time in predicting psychological changes, and whether a low-dose intervention can be designed and disseminated to promote well-being and reduce psychological suffering (given the demands that college students face).

Taken together, despite the applicability of mindfulness EMIs for ameliorating psychological suffering and promoting well-being, there are no extant studies to our knowledge that use text messages rooted in mindfulness practices and psychoeducation for college students. To this end, we adapted evidence-based treatment techniques from mindfulness practice into a low-dose, text messaging smartphone intervention for college students reporting varying levels of psychological distress and aimed to examine the perceived utility and effectiveness of this low-dose intervention. Given that this study was conducted with a heterogeneous sample of college students, in addition to established associations between engagement in mindfulness interventions and improved outcomes, the moderating effect of message usage (engagement) was also examined. In addition to exploring the correlations between

items assessing engagement with the mindfulness messages, the following hypotheses were made:

H1: Compared to individuals assigned to a monitoring-only condition (i.e., ecological momentary assessment (EMA)), individuals assigned to the low-dose, mindfulness-based text message EMI condition would report greater reductions in negative affectivity and emotion dysregulation across the 21-day study period.
H2: Individuals assigned to the EMI condition would report greater increases in components of psychological well-being (i.e., mindfulness, positive affect) across the study period, relative to those in the EMA condition.
H3: Engagement would interact with time in predicting daily positive affect, daily negative affect, daily emotion regulation, and daily mindfulness (if intervention effects were null).
H4: Participants in the EMI condition would find the text messages useful and helpful for building awareness of thoughts, physiological sensations, and behaviors on average.

Method

Participants

Participants ($N = 161$) were undergraduate psychology students 18 years of age or older recruited from an online participant pool at a large, southeastern university ($n = 152$) and social media outlets ($n = 9$). Initially, 213 participants entered the online Qualtrics survey used to collect data. Individual rows of data were excluded for various reasons, including participants not completing the baseline survey, participants who completed the baseline survey more than once, and those who did not complete one of the first seven daily surveys despite being randomized ($n = 10$ individuals). Participants who did not complete one of the first seven daily surveys were not provided with any additional surveys and excluded from further analyses.

Students with differing levels of psychological distress were recruited to capture the full spectrum of psychological functioning and well-being in college students; those currently receiving psychotherapy or pharmacological treatment for mental health problems were included. Participants were required to be undergraduate students. Participants recruited through the university received course credit for participation, and those recruited through social media were entered into a drawing for an Amazon gift card. Study procedures were approved by the university's Institutional Review Board and were consistent with appropriate Helsinki standards. Participants provided consent by checking "yes" at the bottom of the consent form in Qualtrics.

Procedure

After completing the baseline questionnaire, participants were randomized to either the EMI or EMA condition through Qualtrics and were informed that they would be completing brief mindfulness activities and daily surveys or simply completing daily surveys. The single difference between groups was that participants in the EMA condition did not receive the nine mindfulness messages. The Qualtrics surveys were designed to randomly present either the EMA instructions or EMI instructions with evenly presented elements to ensure relatively equal group sizes, and instruction assignment determined condition. Participants from both groups were instructed to respond to questionnaire prompts via text for 21 consecutive days. Questionnaires (see "Daily EMA and EMI Measures" section) and mindfulness messages were sent at 5:00 PM each day through the automated texting service, TellMyCell.

In addition to the 21 daily surveys for each group (completed regardless of condition), participants assigned to the EMI condition received psychoeducational and mindfulness practice text messages to their phone three times per week for the 21-day study period (i.e., days 2, 4, 6, 9, 11, 13, 16, 18, and 20 of the 21-day study). In total, there were three psychoeducational text messages and six mindfulness practice text messages. The psychoeducational and mindfulness messages were repeated, such that the same psychoeducational message was delivered on days 2, 9, and 16, while the same mindfulness prompt was delivered on days 4, 6, 11, 13, 18, and 20. Messages were embedded at the end of the daily monitoring survey within Qualtrics in both audio and readable format. The intervention was designed to be delivered at a lower dose to minimize participant burden. For the psychoeducation messages, participants read a brief description about mindfulness that was intended to provide a brief introduction to mindfulness. On the mindfulness practice days, participants completed a body scan exercise that focused on checking in with breathing and noticing thoughts and feelings. Mindfulness messages were adapted from the Unified Protocol (with permission received from the authors via email; Barlow et al., 2017). The weekly sequence of messages and detailed descriptions are presented at the following Open Science Framework link: https://osf.io/dbx2t/?view_only=f7470b23e264400e9d8c0a8202b4a6ea. After the 21-day study period, participants in the EMI group completed an engagement and likeability survey and were debriefed. Participants who did not receive the text message interventions were afforded the opportunity to receive these messages if they desired, and no participants selected this option.

Power

Power for multilevel models is a debated and complex issue (Field et al., 2012). For purposes of the present

study, an a priori power analysis was conducted using the *nlme* (Pinheiro et al., 2017) and *sjstats* (Lüdecke, 2021) packages in *R*. We simulated power at increasing numbers of participants, hypothesizing a medium change across time for positive affect and selecting a sample size that achieved approximately 90% power (75 participants per group, simulated power = .88).

Measures

Demographics

All participants provided their age, parent/guardian education, income, gender, sex, ethnicity, race, socioeconomic status, and current psychological treatment and medication for mental health difficulties.

Daily EMA and EMI Measures

Positive and Negative Affect Schedule The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) is a 20-item self-report measure that assesses both positive (e.g., interested) and negative (e.g., afraid) affectivity using a 5-point Likert-type scale. Total scores for each subscale range from 10 to 50, with higher scores indicative of higher levels of positive and negative affect. The PANAS has strong psychometric support, with internal consistency coefficients ranging from .86 to .90 for positive affect scales and .84 to .87 for negative affect scales (Watson et al., 1988). When calculating internal consistency at the first time point across participants, alpha was excellent for daily positive affect ($\alpha = .91$) and good for daily negative affect ($\alpha = .87$).

State Difficulties in Emotion Regulation Scale The State Difficulties in Emotion Regulation Scale (S-DERS; Lavender et al., 2017) consists of 21-items that measure four dimensions of state emotion regulation: nonacceptance (difficulty accepting emotions), modulate (ability to respond to emotions), awareness (understanding and attention to emotions), and clarity (limited emotional clarity). The S-DERS utilizes a 5-point scale ranging from 'Not at all' to 'Completely.' Total scores range from 21 to 105, with higher scores indicative of *increased* difficulties regulating emotions (i.e., emotion dysregulation). The S-DERS demonstrates strong psychometric properties, with an alpha level of .86 for the total scale and comparable alpha levels for individual subscales (Lavender et al., 2017). At time one, $\alpha = .90$ for the S-DERS.

Daily Mindfulness Scale To assess daily mindfulness, we used a three-item measure adapting two items from the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) and one item from Brockman et al. (2017). Items assessed the ability to focus on the present moment (i.e., "I found myself preoccupied with the future or the past."), focus on daily experiences (i.e., "I found myself doing things without paying attention.") and accept internal experiences (i.e., "I accepted my feelings, thoughts, and bodily sensations without judging or trying to change them.") across a short time frame (Brockman et al., 2017). This scale utilized a 6-point Likert-type format, with scores ranging from 3 to 18 and higher scores indicating higher levels of daily mindfulness (after reverse scoring the third item). Psychometric support is limited due to the novelty of the measure and combination of items, but the original state MAAS has an internal consistency coefficient of .92 (Brown & Ryan, 2003). Given that this measure is a brief, adapted measure consisting of only three items, the average inter-item correlation across the entire study was calculated ($r = .16$).

Follow-up Measures for EMI Participants

Level of Engagement and Likeability Participants answered four questions regarding their degree of satisfaction and general engagement with the intervention, which were adapted from a previously published questionnaire (Businelle et al., 2016). Participants were asked how often they used information in the text messages in their daily lives on a 5-point scale ranging from "Never" to "Always" (i.e., "How often did you use the information provided in the text messages in your daily life throughout the course of the study?"). Participants also answered if the number of text messages sent was "Too many," "About right," or "Not enough" (i.e., "Was the number of mindfulness activities:"). Additionally, participants were asked the degree to which they were more aware of thoughts, feelings, and behaviors because of the text messages on a 4-point scale ranging from "Definitely yes" to "Definitely not" (i.e., "Because of the text messages, how often would you say that you were more aware of thoughts, feelings, and behaviors?"). The final quantitative question measured whether participants would be likely to recommend learned skills to a friend on a 5-point scale ranging from "Extremely likely" to "Extremely unlikely" (i.e., "How likely would you be to recommend learned mindfulness skills to a friend?").

Data-Analytic Plan

Data Screening Daily data were screened for accuracy errors, missing data, and multivariate assumptions. Data were not imputed, given that MLM is a robust analysis that controls for missing data and the nested participant data (Field et al., 2012). Data were analyzed for participants who were randomized, completed at least one of the first

seven daily surveys, and completed the baseline survey. An attention check (i.e., a single item asking participants to select a specific response) was incorporated into the daily surveys, and individualized surveys failing the attention checks were removed. Regarding timing of survey completion, time was controlled for to include participants who completed surveys outside of the requested time frame (i.e., 5:00 PM to 10:00 AM) by calculating the specific number of days since the start of the first survey (Finkelstein-Fox et al., 2020), and the current study retention rate was comparable to similar EMA studies after screening the data (Pavlacic et al., 2021). By converting completion time to days for each time point, time between two data points could be both calculated and controlled for. For example, if one participant completed the second daily survey 2 days after the first survey, the continuous time variable for survey 1 would be 0 and 2 for survey 2.

Group Equality Given that randomization is expected to produce equal groups across the EMA and EMI conditions, no tests were planned a priori to ensure group equality as there were no suspected problems with randomization (Roberts & Torgerson, 1999). Regardless, *t* tests and chi-square tests were conducted to ensure equivalent groups. The EMA and EMI groups did not differ by age, sex, ethnicity (Hispanic/Latino(a) vs. not Hispanic/Latino(a)), employment (employed vs. not employed), gender (male vs. female were used as comparison groups for these analyses), receiving mental health treatment (yes vs. no), and taking medication for a mental health problem (yes vs. no), as all $ps > .05$.

Attrition To test the potential participant variables related to attrition, participants who completed less than 11 daily surveys were compared to participants who completed greater than or equal to 11 daily surveys using chi-square tests on demographic variables. This split was examined because it represents approximately half of the study. Associations between gender and group, sex and group, employment (employed vs. not employed) and group, and ethnicity (Hispanic/Latino(a) vs. not Hispanic/Latino(a)) and group were not statistically significant. Associations between mental health treatment (yes vs. no) and group were statistically significant, as were associations between taking medication for a mental health problem (yes vs. no) and group. In these cases, for those not receiving mental health treatment or not taking a medication, there were more completers than non-completers.

Multilevel Modeling (MLM) For hypotheses H1 and H2, MLM was used to examine between- and within-group differences throughout both conditions from those who completed the baseline survey and one of the first seven daily surveys for the four primary outcomes (i.e., daily positive affect [PANAS], daily negative affect [PANAS], state emotion regulation [S-DERS], daily mindfulness [Daily Mindfulness Scale]). Given a visual inspection of the data, non-linear changes across time were expected. Therefore, linear, quadratic, and cubic polynomials of time were tested in separate MLMs to determine the appropriate model for time with each outcome. Cubic polynomials were used to model time for all outcomes except daily mindfulness after comparing linear time to both quadratic and cubic polynomials (see below). The time variable for daily mindfulness was modeled as a linear variable. In cases where cubic polynomials were used as fixed effects, the random slope of cubic time was also tested.

After testing effects of time and following guidelines from Field et al. (2012), a random intercept model was compared to a fixed intercept model to determine whether nesting by participant was warranted for each outcome. Data were nested by participant for the remaining analyses and outcomes based on the results obtained from the random intercept models. Then, time and group were added as main effects. The next step consisted of testing the random slope of time (linear or cubic depending on separate MLMs mentioned above). After testing the random slope of time, the time by group fixed effect interaction was added to the final model.

The current study planned to follow up significant interactions, but no significant interactions were observed. Model fit was assessed at each step using Akaike's information criterion (AIC), Schwarz's Bayesian criterion (BIC), and log-likelihood and *p* values (Field et al., 2012). Lower AIC and BIC values are indicative of a better fitting model. While AIC and BIC values were compared across models, a chi-square difference test was also assessed on each model's change in log-likelihood.

Moderator Analyses, Correlations, and Engagement Means Post hoc analyses were conducted to determine if level of engagement assessed at follow-up interacted with daily diary time in predicting daily outcomes by entering each engagement item as a fixed effect for the EMI group (those completing the follow-up who could be matched to daily surveys) for H3. Level of engagement for the EMI group at follow-up was also examined in terms of relationships with daily outcomes for mindfulness, positive affect, negative affect, and emotion dysregulation, controlling for effects of time. For the questions assessing whether participants found the interventions helpful (H4), means were calculated and interpreted at face value based on specific item responses.

Results

Participant Demographics

Of the 161 participants, most ($n = 113$; 70.19%) self-identified as female. Participants were primarily young adults aged

18 ($n = 99$; 61.49%), 19 ($n = 29$; 18.01%), or 20 ($n = 21$; 13.04%). Participants were able to select multiple options and list preferences if their preferred race was not available. Many participants ($n = 130$; 80.75%) identified as white, with most others ($n = 17$; 10.56%) identifying as Black/African American. For ethnicity, almost all ($n = 150$; 93.17%) participants were not Hispanic/Latino(a). Religiosity was equally distributed, and many participants reported being either moderately religious ($n = 54$; 33.54%) or slightly religious ($n = 47$; 29.19%). The most endorsed religion was Christianity ($n = 125$; 77.64%). Regarding current living situation and relevant contextual factors, many participants noted living in a dormitory ($n = 121$; 75.16%), and most were unemployed ($n = 119$; 73.91%). For parental education, 50 (31.06%) participants indicated that their parent(s)/guardian(s) had obtained a 4-year degree, and participants reported annual incomes of mostly $0– $24,999 ($n = 108$; 67.08%). Sixteen (9.94%) participants were receiving a form of counseling or therapy for a mental health problem, and 16 reported taking a medication for a mental health problem.

Daily Data Screening

Daily surveys were excluded for a variety of reasons, including (1) an inability to match specific daily survey ID numbers to ID numbers reported in baseline surveys and (2) failing the attention check item on daily surveys (including those surveys missing the attention check item; $n = 75$ surveys). One participant completed the baseline survey but did not complete the attention check on the one daily survey they completed, and their baseline and daily data were thus excluded. As previously mentioned, participants who completed the baseline data but did not complete any daily surveys were screened out. After cleaning the daily data, the sample consisted of 2817 surveys across 161 participants ($M_{surveys} = 17.50$, $SD_{surveys} = 5.24$). The daily data were then screened for accuracy errors, missingness, and multivariate assumptions. Given that variability in daily surveys is expected using the EMA/EMI design, data were not screened for multivariate outliers using Mahalanobis distance.

After correcting accuracy errors (e.g., reverse scoring and Qualtrics incorrectly coding Likert-type scales), missing data were screened by individual surveys. Most ($n = 2812$ surveys) had no missing data, with some participants missing 2.22% ($n = 2$ surveys), and others missing greater than 5% ($n = 3$ surveys). These five surveys were excluded from further analyses, resulting in 2812 surveys across 160 individuals ($M_{surveys} = 17.58$, $SD_{surveys} = 5.08$). After excluding the five surveys, 80 individuals were in the EMI group ($M_{surveys} = 17.63$, $SD_{surveys} = 5.30$), and 80 individuals ($M_{surveys} = 17.53$, $SD_{surveys} = 4.88$) were in the EMA group. Adherence as measured by number of surveys completed was not statistically significant across groups, $t(158) = -0.12$, $p = .901$. Residuals appeared linear based on visual inspection, with a slight positive skew for multivariate normality upon visually viewing a histogram of residuals. Daily data also appeared to meet assumptions of homogeneity and homoscedasticity based on visual inspection.

Linear, Quadratic, and Cubic Effects of Time

Quadratic and cubic effects of time were tested for each of the four outcomes as detailed above, consistent with recommendations for testing growth over time to ensure a good-fitting model (Field et al., 2012) and given visual inspection of both the raw and *z*-scored data (see Fig. 1). Model 1 consisted of the linear effect of time, while model 2 consisted of the linear and quadratic effects of time. Model 3 consisted of the linear, quadratic, and cubic effects of time. These models also nested data with participants and incorporated a random slope of linear time.

Model fit statistics for each outcome are presented in Table 1. Time was treated as a linear predictor in models for daily mindfulness. For daily positive affect, daily negative affect, and daily state emotion regulation, time was treated as a cubic polynomial in future MLMs. For positive affect, scores appear to indicate an overall decrease over time with fluctuations, while findings for negative affect and emotion dysregulation suggest relatively random fluctuations throughout the study. Fluctuations in daily mindfulness were minimal compared to other assessed constructs. For *z*-scored variability across the study, see Fig. 1.

Intervention Effects (H1 and H2)

Model statistics are presented in Tables 2 and 3 shows statistics for time models, group models, and the time and group interaction model (i.e., each of these models also included a random slope of time tested after entering time and group as fixed effects). The time and group interaction was not statistically significant for any of the four outcomes.[1] In follow-up exploratory models based on the attrition analysis, we examined mental health treatment and medication for a mental health problem as control variables to ensure they did not impact results for H1 and H2. Specifically, these variables were added in the step that included the interaction term. For mental health treatment, the fixed effect of mental health (yes vs. no coded 0 or 1) was not statistically significant in any model, and no significance levels changed for effects in Table 3. For medication (yes vs.

[1] Given the poor reliability for the Daily Mindfulness Scale, MLMs with each mindfulness item as a separate outcome were examined. No interactions were significant in these three models.

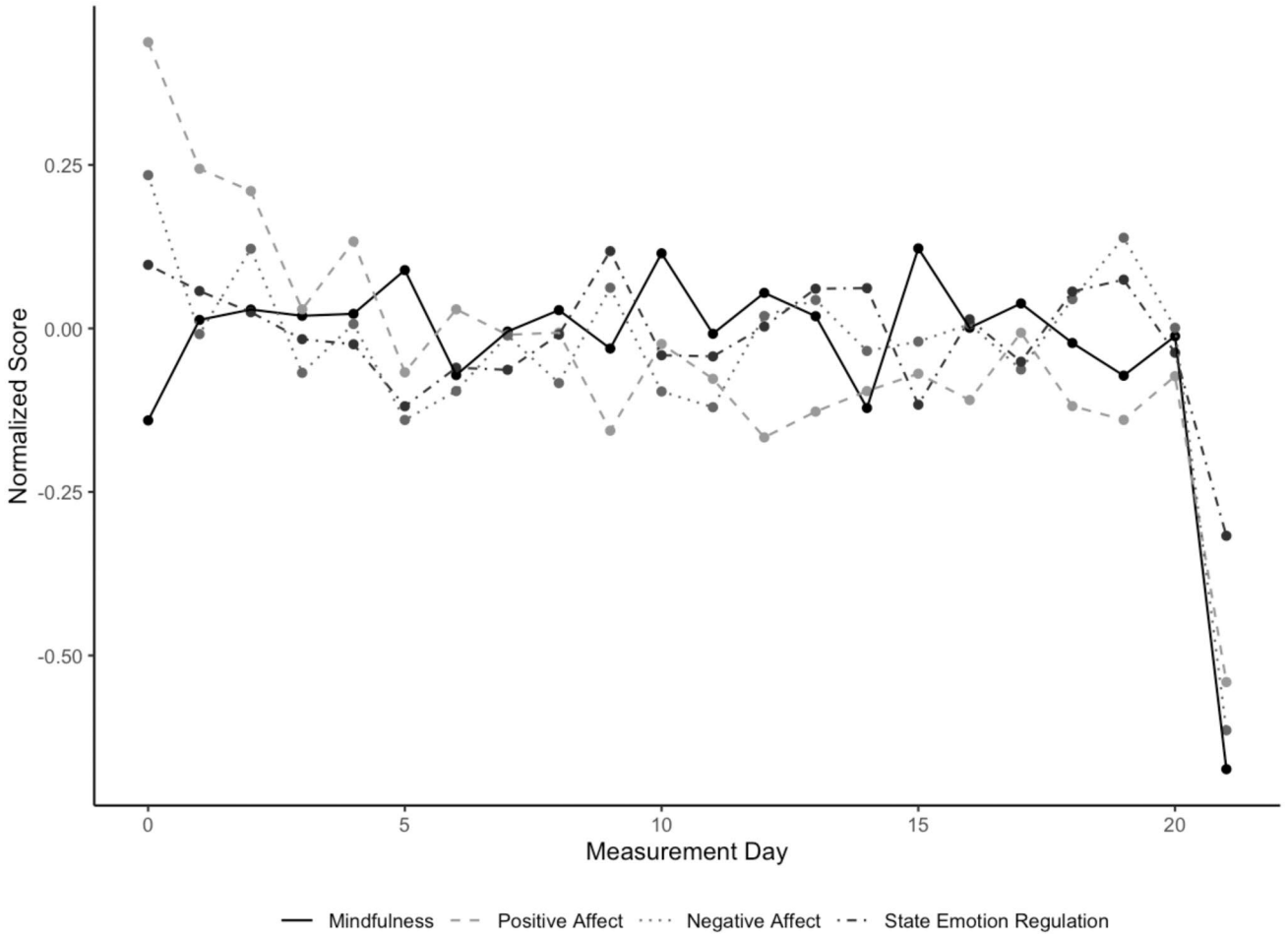

Fig. 1 Centered variability across days for major outcomes. Scores are *z*-scored over the study period (mean is 0). Negative *z*-scores are indicative of lower-than-average scores, while positive *z*-scores indicate higher-than-average scores. These scores are rounded to the nearest day after calculating time since the first survey completed

no coded 0 or 1), no significance levels changed for effects in Table 3. The fixed effect of medication was statistically significant for mindfulness ($b = 1.32$, $p = .016$), negative affect ($b = -4.45$, $p = .002$), and emotion regulation ($b = -10.78$, $p < .001$) models.

Moderator Analyses of Participant Preferences (H3)

Moderator statistics are presented in Table 4. No main effects (i.e., usage of the messages, appropriateness of the activities, level of awareness, likelihood of recommending mindfulness skills to a friend) predicted daily negative affect and daily mindfulness total scores. Participants who reported being less aware of emotions despite receiving mindfulness prompts due to the text messages reported higher emotion dysregulation. As overall usage of mindfulness messages increased, so did positive affect scores. The variance accounted for in daily negative affect, state emotion regulation, daily mindfulness, and daily positive affect scores by engagement items (and controlling for time) was as follows: 3%, 7%, 2%, and 8%. Time did not interact with any engagement items for any outcome.

Overall Participant Preferences (H4)

Supporting H4, participants in the EMI condition reported that they used the mindfulness messages "About half the time" ($M = 3.01$, $SD = 0.94$) and that the number of mindfulness messages was "About right" ($M = 2.10$, $SD = 0.30$). For the awareness item, participants reported "Probably yes" in terms of their often being aware of thoughts, feelings, and behaviors because of the messages ($M = 1.76$, $SD = 0.66$) and that they were "Likely" ($M = 2.15$, $SD = 0.94$) to recommend mindfulness skills to a friend. In examining follow-up correlations for those in the EMI condition completing engagement items ($n = 72$), lack of awareness increased as usage of mindfulness messages decreased ($r = -.29$, $p = .01$; $\rho = -.29$, $p = .01$), and

Table 1 Linear, quadratic, and cubic time effects for mindfulness, affect, and emotion regulation

	AIC	BIC	Log-Likelihood	Likelihood Ratio	*p*
Daily mindfulness					
Linear	10995.24	11030.89	−5491.62		
Linear + quadratic	10993.52	11035.11	−5489.76	3.72	.054
Linear + quadratic + cubic	10994.50	11042.03	−5489.25	1.02	.313
Daily positive affect					
Linear	18147.74	18183.38	−9067.87		
Linear + quadratic	18094.00	18135.59	−9040.00	55.74	< .001
Linear + quadratic + cubic	18085.21	18132.75	−9034.61	10.78	.001
Daily negative affect					
Linear	16443.61	16479.26	−8215.81		
Linear + quadratic	16426.41	16468.00	−8206.21	19.20	< .001
Linear + quadratic + cubic	16422.75	16470.28	−8203.38	5.66	.017
Emotion regulation					
Linear	19121.52	19157.17	−9554.76		
Linear + quadratic	19121.77	19163.37	−9553.89	1.75	.186
Linear + quadratic + cubic	19118.81	19166.34	−9551.40	4.97	.026

Each model was compared to the one above it for purposes of fit statistics. Total scores were used in these models

Table 2 Fit statistics of major outcomes for H1 and H2

	df	AIC	BIC	Log-Likelihood	Likelihood Ratio	*p*
Daily mindfulness						
Fixed intercept	2	13525.84	13537.72	−6760.92		
Random intercept	3	11169.11	11186.93	−5581.55	2358.73	< .001
Time and group	5	11172.64	11202.35	−5581.32	0.47	.791
Random slope of time	7	10996.72	11038.51	−5491.36	179.92	< .001
Time × group interaction	8	10998.24	11045.77	−5491.12	0.48	.491
Daily positive affect						
Fixed intercept	2	20856.10	20867.98	−10426.05		
Random intercept	3	18325.76	18343.58	−9159.88	2532.34	< .001
Time and group	5	18285.23	18314.94	−9137.62	44.52	< .001
Random slope of time	7	18257.71	18299.31	−9121.86	31.52	< .001
Time × group interaction	8	18259.71	18307.24	−9121.86	0.003	.956
Daily negative affect						
Fixed intercept	2	18640.10	18651.98	−9318.05		
Random intercept	3	16633.51	16651.33	−8313.75	2008.59	< .001
Time and group	5	16636.48	16666.19	−8313.24	1.03	.598
Random slope of time	7	16493.18	16534.77	−8239.59	147.30	< .001
Time × group interaction	8	16492.33	16539.86	−8238.16	2.85	.091
Daily emotion regulation						
Fixed intercept	2	22154.42	22166.30	−11075.21		
Random intercept	3	19367.63	19385.46	−9680.82	2788.79	< .001
Time and group	5	19370.99	19400.70	−9680.50	0.64	.726
Random slope of time	7	19160.95	19202.54	−9573.47	214.04	< .001
Time × group interaction	8	19161.25	19208.78	−9572.63	1.70	.193

Each model was compared to the one above it for purposes of fit statistics. Total scores were used in these models

Table 3 Fixed effect statistics for major outcomes for H1 and H2

	b	*df*	*t*	*p*
Daily mindfulness				
Linear time	−0.002	2651	−0.56	.575
Group	0.14	158	0.39	.694
Time × group interaction	−0.01	2650	−0.69	.490
Daily positive affect				
Cubic time	−0.0003	2651	−6.69	< .001
Group	0.39	158	0.30	.765
Time × group interaction	< 0.001	2650	0.06	.956
Daily negative affect				
Cubic time	< 0.001	2651	0.94	.345
Group	0.32	158	0.37	.714
Time × group interaction	< 0.001	2650	1.69	.090
Daily emotion regulation				
Cubic time	< 0.001	2651	0.39	.700
Group	−1.23	158	−0.70	.483
Time × group interaction	< 0.001	2650	1.31	.191

Given that each model was built sequentially (consistent with guidelines for MLM), statistics for each row represent the statistics for when those effects were added to the model. First, time and group were added in a single step after comparing a random intercept model to a fixed intercept model. Then, the random slope was added (i.e., not shown here but explained in text). Finally, the time and group interaction was added as a fixed effect

Table 4 Moderator outcomes for H3

	b	*df*	*t*	*p*
Daily mindfulness				
Usage	0.13	67	0.48	.635
Appropriateness	−0.27	67	−0.33	.741
Awareness	−0.55	67	−1.34	.185
Chance of recommending	0.14	67	0.48	.635
Daily positive affect				
Usage	2.66	67	2.79	.007
Appropriateness	0.21	67	0.08	.940
Awareness	0.82	67	0.57	.570
Chance of recommending	−0.52	67	−0.52	.605
Daily negative affect				
Usage	0.31	67	0.49	.625
Appropriateness	−0.61	67	−0.33	.743
Awareness	0.69	67	0.73	.470
Chance of recommending	1.01	67	1.52	.133
Daily emotion regulation				
Usage	−0.07	67	−0.06	.954
Appropriateness	0.31	67	0.09	.931
Awareness	3.81	67	2.07	.043
Chance of recommending	1.16	67	0.90	.369

These analyses were also calculated with total scores and included a random intercept and random slope of time (linear for mindfulness and cubic for daily positive affect, daily negative affect, and state emotion regulation). Relatedly, time was controlled for in each model (linear for mindfulness and cubic for daily positive affect, daily negative affect, and state emotion regulation)

usage was also associated with an increased likelihood of recommending learned mindfulness skills to a friend (lower scores on the recommendation item reflect increased likelihood; $r = -.29$, $p = .01$; $\rho = -.31$, $p = .008$). Greater lack of awareness was associated with a lower likelihood of recommending mindfulness skills to a friend ($r = .42$, $p < .001$; $\rho = .42$, $p < .001$).

Discussion

The current study examined preferences regarding and effectiveness of a low-dose, mindfulness-based text message EMI for promoting daily positive affect and mindfulness and reducing daily negative affect and emotion dysregulation in college students with varying levels of psychological distress. The intervention was designed to be at a low dose to discern whether a brief intervention could promote positive change (given college student demands), and whether level of engagement in the intervention interacted with time to predict psychological changes. On average, EMI participants found the survey messages to be useful and helpful for building emotional awareness. Contrary to expectations, participants in the EMI group did not report greater increases in daily positive affect and mindfulness or greater reductions in negative affect and emotion dysregulation compared to those in the EMA condition. Although the intervention did not yield significant effects, level of engagement in mindfulness exercises was positively associated with daily positive affect, such that participants who reported higher engagement in the mindfulness activities reported greater levels of positive affect overall. Additionally, participants reporting that mindfulness messages did not increase their emotional awareness evidenced increased daily emotion dysregulation. Further, lack of awareness was related to reductions in usage of the mindfulness message, and usage was positively associated with an increased likelihood of recommending mindfulness skills to a friend (while those less aware were less likely to recommend skills to a friend). These findings have implications for future longitudinal research incorporating experience sampling methods and clinical practice efforts, particularly with the context of designing idiographic, tailored interventions that consider participant preferences.

Multiple factors could explain the null intervention effects. The intervention was designed to be efficient and simple with the aim of eliminating typical treatment barriers students experience. However, the intervention dose may have simply been not strong or intensive enough to promote meaningful change in affect, mindfulness, or emotion dysregulation. For example, existing mindfulness-based, technology-driven interventions are typically longer than the EMI employed in the current study (e.g., Ahmad et al., 2020; Trub & Starks, 2017). There is also

some evidence to suggest that, while additional research is needed, higher-dose mindfulness interventions increase effects (e.g., Parsons et al., 2017). Given that mindfulness is one potential mechanism that explains the link between mindfulness-based interventions and mental health outcomes (Gu et al., 2015), diversifying the intervention in terms of number of skills taught and time spent practicing seems a reasonable next step in designing EMIs. Additionally, it is possible that the mindfulness prompts were not engaging or interactive enough to sustain participants' attention and promote full engagement, and/or could have benefitted from incorporation of supplemental media (e.g., video clips; see also Langdon et al., 2021). Third, the context in which participants completed the surveys and mindfulness activities (e.g., socializing with friends, completing a homework assignment) may have contributed to not fully completing or ignoring mindfulness prompts. Regression to the mean effects could have also masked benefits from the EMI. Considering the demonstrable evidence base regarding the effectiveness of mindfulness-based interventions (Bamber & Morpeth, 2019; Chiodelli et al., 2020), these reasons may be plausible explanations for the null findings.

Null findings notwithstanding, greater engagement with the mindfulness exercise was associated with higher positive affect, while lack of awareness was associated with greater emotion dysregulation. Dispositional deficits in emotion regulation (as opposed to lack of engagement with the EMI specifically) may have attenuated the effect of the mindfulness activities, in particular for participants lacking emotional awareness and/or those prone to using avoidance strategies (Prakash et al., 2017). A robust relationship between mindfulness and emotion regulation exists (Hill & Upderaff, 2012), and emotion (dys) regulation is thought to be an important mechanism through which mindfulness contributes to affect and mental health outcomes (Cheung et al., 2020; Gratz & Tull, 2010; Hill & Upderaff, 2012). That is, mindfulness reduces negative affect and enhances well-being by improving emotion regulation. It is possible that mindfulness exercises in the present study did not address underlying emotion dysregulation well enough, therefore stymying possible intervention effects. Emotion regulation skills could be incorporated into mindfulness-based EMIs and should be tailored to the individual's specific deficits, as specific dimensions of emotion dysregulation may be related to different outcomes (Gratz & Tull, 2010).

Limitations

In addition to the above methodological considerations, other limitations warrant consideration. The sample was exclusively comprised of college students who primarily identified as white and female. Results may not fully generalize to community samples, diverse samples of university students, or clinical samples experiencing higher levels of psychological distress (given that the sample reported primarily subclinical levels of distress as evidenced by Depression Anxiety Stress Scale scores, with some variability; Lovibond & Lovibond, 1995). Additionally, while the length of the study is a strength allowing for examination of idiographic differences, repeatedly assessing constructs over extended periods of time could have also confounded results. To address this concern, attention checks were implemented to address random responding with a single item on each survey, and time was controlled for in all analyses. Relatedly, using self-report measures to assess engagement in a digital intervention is also a limitation (given that it is based on participant perceptions), as is assessing constructs daily as opposed to multiple times each day (i.e., which would have allowed for examination of relationships within-days; see also Enkema et al., 2020, for an overview of EMA studies studying mindfulness). Finally, given the poor reliability for the Daily Mindfulness Scale, these results should be interpreted cautiously.

Future Research and Clinical Implications

At a broader level, continued efforts to examine constructs assessed cross-sectionally in multilevel frameworks will provide greater insight into within-individual/idiographic fluctuations in respective constructs over time (Finkelstein-Fox et al., 2020), whether that be through treatment studies with EMI components or observational EMA studies with diverse samples. For the former, incorporating EMA and/or EMI methods into clinical research trials could help researchers understand processes of change within intervention conditions, providing clinicians with a more solidified and nuanced understanding of the processes promoting positive change from a given intervention (and thus elucidating clearer intervention targets). Models incorporating idiographic analytic methods will also allow for individually tailored treatment programs. The intervention employed in the current study is limited without the ability to tailor the specific intervention components to the individual. Integrating EMIs with idiographic intervention approaches will allow for the application of different therapeutic procedures to individualized presenting problems. As an example, technology-driven research programs may consider incorporating both predetermined and 'on-demand' messages that can be delivered at the request of the user (Langdon et al., 2021), which could increase both acceptability and effectiveness. The current intervention encapsulates the former regarding predetermined messages but was limited without the ability to tailor evidence-based procedures due to limited funding mechanisms. Therefore, future research efforts should ideally incorporate a broader range of evidence-based strategies that can be selected by the individual (in addition to automated strategies). Concurrently integrating burst designs with surveys sent multiple times per day would allow for a more individualized delivery of the intervention. Regardless,

delivering the EMI component at a higher frequency is an appropriate next step for enhancing the impact of the intervention and better understanding within-individual differences and preferences within and across days.

Summary Conclusion

Next steps for designing stronger EMIs are identified, consistent with extant literature demonstrating the effectiveness and efficacy of Web-based and app-based programs using mindfulness techniques for ameliorating psychological distress and promoting psychological well-being. Ideally, future interventions will be more idiographic and tailored to the individual, incorporating a combination of standardized text messages and messages that can be delivered at the request of the individual. These interventions may also choose to target underlying emotion dysregulation, which may drive mindfulness capabilities.

Author Contribution The draft of the manuscript was written by Jeffrey Pavlacic; all authors provided edits. All authors contributed to study conception and design and read and approved the final manuscript.

Declarations

Ethical Approval This study was approved by the Institutional Review Board at the University of Mississippi, and consent was obtained from participants.

Conflict of Interest The authors declare no competing interests.

Data Availability Data will be made available upon reasonable request.

References

Ahmad, F., El Morr, C., Ritvo, P., Othman, N., Moineddin, R., & MVC Team. (2020). An eight-week, web-based mindfulness virtual community intervention for students' mental health: Randomized controlled trial. *JMIR Mental Health, 7*(2), e15520. https://doi.org/10.2196/15520

Alsubaie, M. M., Stain, H. J., Webster, L. A., & Wadman, R. (2019). The role of sources of social support on depression and quality of life for university students. *International Journal of Adolescence and Youth, 24*(4), 484–496. https://doi.org/10.1080/02673843.2019.1568887

Auerbach, R. P., Alonso, J., Axinn, W. G., Cuijpers, P., Ebert, D. D., Green, J. G., Hwang, I., Kessler, R. C., Liu, H., Mortier, P., Nock, M. K., Pinder-Amaker, S., Sampson, N. A., Aguilar-Gaxiola, S., Al-Hamzawi, A., Andrade, L. H., Benjet, C., Caldas-de-Almeida, J. M., Demyttenaere, K., & Bruffaerts, R. (2016). Mental disorders among college students in the World Health Organization World Mental Health Surveys. *Psychological Medicine, 46*(14), 2955–2970. https://doi.org/10.1017/S0033291716001665

Bambacus, E. S., & Conley, A. H. (2021). The impact of dosage on a mindfulness intervention with first-year college students. *Journal of College Student Retention: Research, Theory, & Practice*. Advance online publication. https://doi.org/10.1177/15210251211041695

Bamber, M. D., & Morpeth, E. (2019). Effects of mindfulness meditation on college student anxiety: A meta-analysis. *Mindfulness, 10*(2), 203–214. https://doi.org/10.1007/s12671-018-0965-4

Barlow, D. H., Farchione, T. J., Sauer-Zavala, S., Latin, H. M., Ellard, K. K., Bullis, J. R., Bentley, K. H., Boettcher, H. T., & Cassiello-Robbins, C. (2017). *Unified Protocol for transdiagnostic treatment of emotional disorders: Therapist guide*. Oxford University Press.

Bergen-Cico, D., Possemato, K., & Cheon, S. (2013). Examining the efficacy of a brief mindfulness-based stress reduction (brief MBSR) program on psychological health. *Journal of American College Health, 61*(6), 348–360. https://doi.org/10.1080/07448481.2013.813853

Brockman, R., Ciarrochi, J., Parker, P., & Kashdan, T. (2017). Emotion regulation strategies in daily life: Mindfulness, cognitive reappraisal and emotion suppression. *Cognitive Behaviour Therapy, 46*(2), 91–113. https://doi.org/10.1080/16506073.2016.1218926

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Businelle, M. S., Ma, P., Kendzor, D. E., Frank, S. G., Vidrine, D. J., & Wetter, D. W. (2016). An ecological momentary intervention for smoking cessation: Evaluation of feasibility and effectiveness. *Journal of Medical Internet Research, 18*(12), e321. https://doi.org/10.2196/jmir.6058

Byrne, S. P., Haber, P., Baillie, A., Costa, D. S., Fogliati, V., & Morley, K. (2019). Systematic reviews of mindfulness and acceptance and commitment therapy for alcohol use disorder: Should we be using third wave therapies? *Alcohol and Alcoholism, 54*(2), 159–166. https://doi.org/10.1093/alcalc/agy089

Cheung, R. Y., Ke, Z., & Ng, M. C. (2020). Dispositional mindfulness and mental health in Chinese emerging adults: A multilevel model with emotion dysregulation as a mediator. *PLoS ONE, 15*(11), e0239575. https://doi.org/10.1371/journal.pone.0239575

Chiodelli, R., Mello, L. T. N. D., Jesus, S. N. D., Beneton, E. R., Russel, T., & Andretta, I. (2020). Mindfulness-based interventions in undergraduate students: A systematic review. *Journal of American College Health, 70*(3), 1–10. https://doi.org/10.1080/07448481.2020.1767109

Crane, C., Crane, R. S., Eames, C., Fennell, M. J., Silverton, S., Williams, J. M. G., & Barnhofer, T. (2014). The effects of amount of home meditation practice in mindfulness based cognitive therapy on hazard of relapse to depression in the Staying Well after Depression Trial. *Behaviour Research and Therapy, 63*, 17–24. https://doi.org/10.1016/j.brat.2014.08.015

Enkema, M. C., McClain, L., Bird, E. R., Halvorson, M. A., & Larimer, M. E. (2020). Associations between mindfulness and mental health outcomes: A systematic review of Ecological Momentary Assessment research. *Mindfulness, 11*(11), 2455–2469. https://doi.org/10.1007/s12671-020-01442-2

Ennis, E., McLafferty, M., Murray, E., Lapsley, C., Bjourson, T., Armour, C., Bunting, B., Murphy, S., & O'Neill, S. (2019). Readiness to change and barriers to treatment seeking in college students with a mental disorder. *Journal of Affective Disorders, 252*, 428–434. https://doi.org/10.1016/j.jad.201904.062

Field, A., Miles, J., & Field, Z. (2012). *Discovering statistics using R*. SAGE.

Finkelstein-Fox, L., Pavlacic, J. M., Buchanan, E. M., Schulenberg, S. E., & Park, C. L. (2020). Valued living in daily experience: Relations with mindfulness, meaning, psychological flexibility, and stressors. *Cognitive Therapy and Research, 44*(2), 300–310. https://doi.org/10.1007/s10608-019-10062-7

Givens, J. L., & Tjia, J. (2002). Depressed medical students' use of mental health services and barriers to use. *Academic Medicine, 77*(9), 918–921.

Gluck, T. M., & Maercker, A. (2011). A randomized controlled pilot study of a brief web-based mindfulness training. *BMC Psychiatry, 11*(1), 175. https://doi.org/10.1186/1471-244X-11-175

Gratz, K. L., & Tull, M. T. (2010). Emotion regulation as a mechanism of change in acceptance- and mindfulness-based treatments. In R. A. Baer (Ed.), *Assessing mindfulness and acceptance: Illuminating the processes of change* (pp. 107–133). New Harbinger Publications.

Greeson, J., Garland, E. L., & Black, D. (2014). Mindfulness: A transtherapeutic approach for transdiagnostic mental processes. In A. Ie, C. T. Ngnoumen, & E. J. Langer (Eds.), *The Wiley Blackwell handbook of mindfulness* (pp. 533–562). John Wiley & Sons, Ltd.

Gu, J., Strauss, C., Bond, R., & Cavanagh, K. (2015). How do mindfulness-based cognitive therapy and mindfulness-based stress reduction improve mental health and wellbeing? A systematic review and meta-analysis of mediation studies. *Clinical Psychology Review, 37*, 1–12. https://doi.org/10.1016/j.cpr.2015.01.006

Heron, K. E., & Smyth, J. M. (2010). Ecological momentary interventions: Incorporating mobile technology into psychosocial and health behaviour treatments. *British Journal of Health Psychology, 15*(1), 1–39. https://doi.org/10.1348/135910709X466063

Hill, C. L., & Upderaff, J. A. (2012). Mindfulness and its relationship to emotional regulation. *Emotion, 12*(1), 81–90. https://doi.org/10.1037/a0026355

Hilton, L., Hempel, S., Ewing, B. A., Apaydin, E., Xenakis, L., Newberry, S., Colaiaco, B., Maher, A. R., Shanman, R. M., Sorbero, M. E., & Maglione, M. A. (2017). Mindfulness meditation for chronic pain: Systematic review and meta-analysis. *Annals of Behavioral Medicine, 51*(2), 199–213. https://doi.org/10.1007/s12160-016-9844-2

Jennings, K. S., Goguen, K. N., Britt, T. W., Jeffirs, S. M., Wilkes, J. R. III., Brady, A. R., Pittman, R. A., & DiMuzio, D. J. (2017). The role of personality traits and barriers to mental health treatment seeking among college students. *Psychological Services, 14*(4), 513–523. https://doi.org/10.1037/ser0000157

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*(2), 144–156. https://doi.org/10.1093/clipsy.bpg016

Komiya, N., Good, G. E., & Sherrod, N. B. (2000). Emotional openness as a predictor of college students' attitudes toward seeking psychological help. *Journal of Counseling Psychology, 47*(1), 138–143. https://doi.org/10.1037/0022-0167.47.1.138

Kuhlman, S. T., McDermott, R. C., Kridel, M. M., & Kantra, L. M. (2019). College students' peer-helping behaviors and stigma of seeking help: Testing a moderated mediation model. *Journal of American College Health, 67*(8), 753–761. https://doi.org/10.1080/07448481.2018.1506791

Langdon, K. J., Scherzer, C., Ramsey, S., Carey, K., Rich, J., & Ranney, M. L. (2021). Feasibility and acceptability of a digital health intervention to promote engagement in and adherence to medication for opioid use disorder. *Journal of Substance Abuse Treatment, 131*, 108538. https://doi.org/10.1016/j.sat.2021.108538

Lavender, J. M., Tull, M. T., DiLillo, D., Messman-Moore, T., & Gratz, K. L. (2017). Development and validation of a state-based measure of emotion dysregulation: The State Difficulties in Emotion Regulation Scale (S-DERS). *Assessment, 24*(2), 197–209. https://doi.org/10.1177/1073191115601218

Levin, M. E., MacLane, C., Daflos, S., Seeley, J. R., Hayes, S. C., Biglan, A., & Pistorello, J. (2014). Examining psychological inflexibility as a transdiagnostic process across psychological disorders. *Journal of Contextual Behavioral Science, 3*(3), 155–163. https://doi.org/10.1016/j.jcbs.2014.06.003

Levin, M. E., Stocke, K., Pierce, B., & Levin, C. (2018). Do college students use online self-help? A survey of intentions and use of mental health resources. *Journal of College Student Psychotherapy, 32*(3), 181–198. https://doi.org/10.1080/87568225.2017.1366283

Lindsay, E. K., Young, S., Smyth, J. M., Brown, K. W., & Creswell, J. D. (2018). Acceptance lowers stress reactivity: Dismantling mindfulness training in a randomized controlled trial. *Psychoneuroendocrinology, 87*, 63–73. https://doi.org/10.1016/j.psyneuen.2017.09.015

Lovibond, P. G., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy, 33*, 335–343. https://doi.org/10.1016/0005-7967(94)00075-u

Lucas-Thompson, R. G., Broderick, P. C., Coatsworth, J. D., & Smyth, J. M. (2019). New avenues for promoting mindfulness in adolescence using mHealth. *Journal of Child and Family Studies, 28*(1), 131–139. https://doi.org/10.1007/s10826-018-1256-4

Lucas-Thompson, R. G., Rayburn, S., Seiter, N. S., Broderick, P. C., Smyth, J. M., Coatsworth, J. D., & Henry, K. L. (2020). Learning to BREATHE "Plus": A multi-modal adaptive supplement to an evidence-based mindfulness intervention for adolescents. *Frontiers in Public Health*. https://doi.org/10.3389/fpubh.2020.579556

Lüdecke, D. (2021). *sjstats: Statistical Functions for Regression Models (Version 0.18.1)*. https://doi.org/10.5281/zenodo.1284472. https://CRAN.R-project.org/package=sjstats.

Morton, M. L., Helminen, E. C., & Felver, J. C. (2020). A systematic review of mindfulness interventions on psychophysiological responses to acute stress. *Mindfulness, 11*(9), 2039–2054. https://doi.org/10.1007/s12671-020-01386-7

Olmstead, S. B., Roberson, P. N., & Fincham, F. D. (2016). Early psychological distress is a precursor to college men's later academic and social adjustment. *College Student Journal, 50*(1), 53–58.

Parsons, C. E., Crane, C., Parsons, L. J., Fjorback, L. O., & Kuyken, W. (2017). Home practice in mindfulness-based cognitive therapy and mindfulness-based stress reduction: A systematic review and meta-analysis of participants' mindfulness practice and its association with outcomes. *Behaviour Research and Therapy, 95*, 29–41. https://doi.org/10.1016/j.brat.2014.08.015

Pavlacic, J. M., Schulenberg, S. E., & Buchanan, E. M. (2021). Experiential avoidance and meaning in life as predictors of valued living: A daily diary study. *Journal of Prevention and Health Promotion, 2*(1), 135–159. https://doi.org/10.1177/2632077021998261

Pinheiro, J., Bates, D., DebRoy, S., Sarkar, D., & R Core Team. (2017). *nlme: linear and nonlinear mixed effects models*. R package version 3.1–131. https://CRAN.R-project.org/package=nlme

Prakash, R. S., Whitmoyer, P., Aldao, A., & Schirda, B. (2017). Mindfulness and emotion regulation in older and young adults. *Aging & Mental Health, 21*(1), 77–87. https://doi.org/10.1080/13607863.2015.1100158

Roberts, C., & Torgerson, D. J. (1999). Baseline imbalance in randomised controlled trials. *BMJ, 319*(7203), 185. https://doi.org/10.1136/bmj.319.7203.185

Sakiris, N., & Berle, D. (2019). A systematic review and meta-analysis of the Unified Protocol as a transdiagnostic emotion regulation based intervention. *Clinical Psychology Review, 72*, 101751. https://doi.org/10.1016/j.cpr.2019.1017751

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Strohmaier, S. (2020). The relationship between doses of mindfulness-based programs and depression, anxiety, stress, and mindfulness: A dose-response meta-regression of randomized controlled trials. *Mindfulness, 11*(6), 1315–1335. https://doi.org/10.1007/s12671-020-01319-4

Tang, M. O., Oliffe, J. L., Galdas, P. M., Phinney, A., & Han, C. S. (2014). College men's depression-related help-seeking: A gender analysis. *Journal of Mental Health, 23*(5), 219–224. https://doi.org/10.3109/09638237.2014.910639

Taylor, B. L., Strauss, C., Cavanagh, K., & Jones, F. (2014). The effectiveness of self-help mindfulness-based cognitive therapy in a student sample: A randomized controlled trial. *Behaviour Research and Therapy, 63*, 63–69. https://doi.org/10.1016/j.brat.2014.09.007

Trub, L., & Starks, T. J. (2017). Textual healing: Proof of concept study examining the impact of a mindfulness intervention on smartphone behavior. *Mindfulness, 8*(5), 1225–1235. https://doi.org/10.1007/s12671-017-0697-y

Versluis, A., Verkuil, B., Spinhoven, P., van der Ploeg, M. M., & Brosschot, J. F. (2016). Changing mental health and positive psychological well-being using ecological momentary interventions: A systematic review and meta-analysis. *Journal of Medical Internet Research, 18*(6), e152. https://doi.org/10.2196/jmir.5642

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070.