HHS Public Access

Author manuscript

Mindfulness (N Y). Author manuscript; available in PMC 2020 April 01.

Published in final edited form as:

Mindfulness (N Y). 2019 April ; 10(4): 627–638. doi:10.1007/s12671-018-1022-0.

Mindfulness Training Reduces Stress At Work: A Randomized Controlled Trial

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Abstract

Mindfulness-based interventions have been suggested as one way to improve employee well-being in the workplace. Despite these purported benefits, there have been few well-controlled randomized controlled trials (RCTs) evaluating mindfulness training in the workplace. Here we conducted a two-arm RCT at work among employees of a digital marketing firm comparing the efficacy of a high dose six-week mindfulness training to a low dose single-day mindfulness training for improving multiple measures of employee well-being assessed using ecological momentary assessment. High dose mindfulness training reduced both perceived and momentary stress, and buffered employees against worsened affect and decreased coping efficacy compared to low dose mindfulness training. These results provide well-controlled evidence that mindfulness training programs can reduce momentary stress at work, suggesting that more intensive mindfulness training doses (i.e., 6-weeks) may be necessary for improving workplace well-being outcomes. This RCT utilizes a novel experience sampling approach to measure the effects of a mindfulness intervention on employee well-being and considers potential dose-response effects of mindfulness training at work.

Keywords

mindfulness; stress; coping; well-being

Over the past decade, there has been a dramatic increase in the use of mindfulness training programs in the workplace (Good et al., 2016; Lomas et al., 2017). Corporations such as Aetna, General Mills, and Goldman Sachs have begun to implement mindfulness meditation

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Author contributions

BC: Performed the data analysis, wrote the paper. JS: Executed the study, assisted with the data analysis, assisted with designing the study, collaborated in writing and editing of the manuscript. JR: Assisted with executing the study, wrote part of the methods, collaborated in writing and editing of the manuscript. JDC: Designed the study, supervised execution of the study, supervised data analysis, supervised manuscript preparation.

Compliance with ethical standards

Informed consent was obtained from all individual participants in this study. All procedures performed in studies involving human participants were in accordance with the ethical standards of the Carnegie Mellon University Institutional Review Board and the American Psychological Association.

Conflict of Interest: Julianna Raye is a senior trainer with Unified Mindfulness. Brian Chin, Jerry Slutsky, and J. David Creswell declare no conflict of interest.

training programs for their employees (Gelles, 2015). Indeed, a recent survey of the United States workforce found nearly one in six white-collar workers reported engaging in some form of mindfulness-based practice over the previous year (Kachan et al., 2017). Numerous CEOs also report integrating mindfulness meditation into their daily routines, providing anecdotal evidence that this practice has helped them to build resilience against stressors, focus their attention, and improve their interpersonal work relationships (Seppala, 2015). One reason for this surge in popularity is that mindfulness practices train an open attention and awareness to present moment experiences, which may foster greater self-regulation and performance (Brown, Ryan, & Creswell, 2007; Glomb, Yang, Bono, & Duffy, 2011). However, the immense popularity of the organizational mindfulness movement has led some to argue for the necessity of a more balanced and rigorous assessment of mindfulness training in the workplace (Brendel, 2015). Despite its purported benefits, there have been few well-controlled randomized controlled trials (RCTs) evaluating mindfulness training in the workplace (Good et al., 2016).

Previous research has demonstrated initial benefits of mindfulness interventions in workplace settings such as hospitals (e.g., Krasner et al., 2009) and schools (e.g., Harris, Jennings, Katz, Abenavoli, & Greenberg, 2016; Roeser et al., 2013). However, there have been few well-controlled studies testing the effects of a mindfulness-based intervention in for-profit organizations (see critique by Lomas et al., 2017). The few previous randomized controlled trials of mindfulness training programs in for-profit workplaces have provided promising initial evidence that mindfulness based interventions can reduce stress and increase resilience among employees (Aikens et al., 2014; Shonin, Gordon, Dunn, Singh, & Griffiths, 2014; Wolever et al., 2012). However, one limitation of these previous studies is that all of them have utilized either a waitlist control group (Aikens et al., 2014; Hülsheger, Feinholdt, & Nübold, 2015; Wolever et al., 2012) or non-equivalent comparison groups such as yoga (e.g., Wolever et al., 2012) or cognitive behavioral therapy (CBT; e.g., Shonin, Gordon, Dunn, Singh, & Griffiths, 2014). In the latter case, mindfulness programs have shown little relative advantage compared to these different treatment programs. For example, Wolever et al. (2012) found no differences between a mindfulness and yoga-based intervention in reducing perceived stress, depressive symptoms, sleep difficulties, or health-related work limitations. One possible reason that these studies did not find any additional benefits of mindfulness training relative to control trainings may be that these comparator programs also included some of the same components as mindfulness training and may have therefore masked any potential benefits. Alternatively, it is also possibility that mindfulness interventions may be just as beneficial as these other behavioral treatments.

Additionally, it is unclear from previous research how much mindfulness intervention is needed to experience workplace benefits. Developing a better understanding of the dose-response effects of mindfulness interventions for different outcomes is necessary to facilitate the design of more efficacious and efficient workplace interventions (Carmody & Baer, 2009; Creswell, 2017). Specifically, it may be particularly informative to examine which workplace benefits can be achieved with a brief lower dose mindfulness training and which benefits may only be observed following a longer-term higher dose mindfulness-based intervention. For example, it has been shown previously that a more intensive, longer-term

mindfulness intervention improves clinical markers of physical health in patient populations relative to a single day mindfulness workshop (Creswell, Myers, Cole, & Irwin, 2009).

An additional limitation of earlier investigations of mindfulness-based interventions in for-profit workplaces is a reliance on global retrospective self-report measures to evaluate primary study outcomes which can introduce multiple forms of bias (Nisbett & Wilson, 1977). To this end, the use of ecological momentary assessment (EMA) to measure momentary experience during the workday may be particularly beneficial. EMA is particularly well-suited to capture dynamic processes such as stress and changes in affect throughout the day (Shiffman, Stone, & Hufford, 2008; Smyth & Stone, 2003). Compared to standard retrospective assessments, the use of EMA is advantageous because this approach boosts ecological validity (e.g., Anestis et al., 2010), reduces memory biases associated with retrospective reporting (Stone & Broderick, 2007), and provides novel insight and greater sensitivity to detect change (e.g., Moore, Depp, Wetherell, & Lenze, 2016; Solhan, Trull, Jahng, & Wood, 2009).

One important workplace domain potentially influenced by mindfulness meditation is employee well-being (Good et al., 2016; Hyland, Lee, & Mills, 2015). Employee well-being refers to the general quality of an employee's experience at work and is thought to encompass both general emotional tone and resilience during stressful events such as coworker conflict or poor performance evaluations (Good et al., 2016). Earlier evidence suggests that mindfulness in the workplace may be associated with improvements in employee well-being. For example, one cross-sectional survey of CEOs, middle managers, and junior managers found that higher trait mindfulness was associated with lower levels of depression, anxiety, and negative affect (Roche, Haar, & Luthans, 2014). Similarly, studies in other types of occupational settings such as schools have found that teachers assigned to complete a mindfulness training intervention decreased in perceived stress and increased in self-compassion compared to those assigned to a waitlist control group (Roeser et al., 2013). Finally, one recent study found that a behavioral self-monitoring intervention increased mindfulness and reduced work-to-family conflict (Kiburz, Allen, & French, 2017).

Stress in the workplace is harmful to employee well-being and can lead to increased absenteeism, organizational dysfunction, and decreased productivity (Colligan & Higgins, 2006). Many studies have shown that mindfulness interventions reliably reduce both overall psychological stress (for a review, see Creswell & Lindsay, 2014) and occupational distress (review by Virgili, 2015). Furthermore, other evidence suggests that mindfulness is associated with improved coping success and resilience during stressful events (e.g., Weinstein, Brown, & Ryan, 2009), though none of these previous studies have measured stress and coping using EMA in the workplace.

The role of affect in the workplace has also long been recognized as an important area of research (Muchinsky, 2000). Mindfulness interventions have previously been theorized to promote positive emotional states at work (Good et al., 2016). Indeed, mindfulness interventions have been shown to be associated with increased positive affect and decreased negative affect in a number of settings (reviews by Creswell, 2017; Eberth & Sedlmeier, 2012).

The aim of the current study was to examine the potential dose-response effects of mindfulness training for improving well-being in the workplace. To do this, we randomly assigned employees of a digital marketing firm to complete either: (i) a single-day mindfulness training workshop followed by a six-week mindfulness intervention ("high dose" mindfulness training; HDMT); or (ii) a single-day mindfulness training workshop only ("low dose" mindfulness training; LDMT). EMA was used to measure stress, coping, and affect during working hours at baseline and following the intervention period. We hypothesized that HDMT would decrease overall stress, increase coping efficacy when stressful events did occur, reduce negative affect, and increase positive affect relative to LDMT.

Method

Participants

There were 60 adults between the ages of 21–57 (M=30.52, SD=7.80) enrolled in the study. The sample was 66.7% female and 95.0% white. All participants were recruited from a digital marketing firm based in Ohio for a study testing the effects of mindfulness training in the workplace. This firm consists of approximately 100 employees that work with a diverse range of clients including educators, lawyers, and consumer brands. Work at this firm focuses on digital advertising, content marketing, search engine optimization, and public relationships. Employees spend a typical workday interacting with clients, managing accounts, and creating digital content in a fast-paced work environment. Notably, the firm experienced a period of significant organizational change and major restructuring during the study's intervention and assessment period which was expected to raise overall stress levels.

Of the 60 randomized participants, 58 completed the intervention (96.7%). Both participants who dropped out of the intervention were assigned to the HDMT group (n=2). In addition, 54 participants (90.0%) responded to at least one post-intervention experience sampling assessment and 51 participants (85.0%) completed the post-intervention questionnaire battery (see Figure 1). Following intent-to-treat principles, these participants were included in primary analyses but not in estimates of daily practice for the HDMT group. Eligible participants were fluent English-speaking smartphone owners (Android or iPhone) over the age of 18. Individuals with significant experience (defined as daily practice for at least one of the previous six months) with or daily practice of mindfulness meditation or related mind-body practices were also excluded. Written informed consent was obtained from all participants, and all study procedures were approved by the home university's institutional IRB. Participants received free mindfulness training but were not additionally compensated for their participation. This approach was adopted with an implementation science goal, as companies are likely to offer mindfulness programs for free but unlikely to provide additional compensation beyond company time. Study data were collected between September 2016 and November 2016.

Procedures

Interested participants first completed an eligibility prescreening via online questionnaire which assessed whether they were interested in participating, owned a smartphone, spoke

English, were between ages 18–70, were available for the entire 8-week study period, and did not have daily practice with mindfulness for at least one month within the previous six months. Those who were eligible then provided informed consent and completed baseline questionnaires. On Tuesday, Wednesday, and Thursday of the following week, participants completed three days of baseline ecological momentary assessments and daily diaries. Ecological Momentary Assessment (EMA) involves intensive sampling of participant experiences in real time during a typical day. Here we used experience sampling assessments administered during the workday to measure momentary stress, coping, and affect in the natural work environment. Experience sampling assessments were administered using participants' personal smartphones via MetricWire (Kitchener, Ontario). Participants were prompted to complete experience sampling surveys via text links sent during each of four 2-hour blocks distributed between 9:00 am and 5:00 pm with links expiring after 45 minutes. There were 24 experience sampling assessments in total across the baseline and post-intervention periods.

The following week, participants attended one of three identical 4-hour in-person mindfulness workshops based on availability; workshops were held on consecutive days (Monday, Tuesday, and Wednesday). There were two participants (3.3%) who attended this workshop via video chat. All workshops were led by the same senior mindfulness instructor trained in the Unified Mindfulness system (Young, 2016). Immediately following completion of this workshop, participants were randomly assigned to one of two study conditions using a random number generator: (i) high dose mindfulness training (HDMT); or (ii) low dose mindfulness training (LDMT). The content of the workshop and HDMT intervention are described below. Participants randomized to the LDMT did not receive any additional mindfulness instruction during the intervention period and were explicitly asked to refrain from any additional mindfulness practice until the conclusion of the study.

Following the 6-week intervention period, all participants completed three days of post-intervention experience sampling and daily diary assessments; these assessments were completed during the week immediately following the intervention on the same days of the week as baseline assessments (Tuesday through Thursday). Next, participants completed a post-intervention battery of questionnaires and tasks during the week following post-intervention experience sampling. Finally, all participants were debriefed, informed of the study's aims, and thanked for their participation. For a complete timeline of study procedures see Table 1.

Intervention.—The in-person workshop consisted of both direct instruction and guided activities. Participants were provided with didactic information about mindful awareness, including a description of the mechanisms through which mindfulness can improve various dimensions of well-being. Participants were also provided with a conceptual framework for classifying sensory experience and a description of the range of situations in which mindfulness practice can be done. Participants were then guided through exercises intended to foster an ability to monitor and accept one's current visual, auditory and somatic sensory experiences, and create positive emotional states. These exercises included both formal and informal practice performed while completing routine activities including mindful dyadic conversations, mindful eating, and mindful music listening. During these exercises,

participants were taught an open awareness technique which allows attention to move freely between sensory modalities, as well as a technique that narrows attention to focus on a single sensory modality. They were also taught techniques intended to cultivate pleasant bodily emotion. Both the didactic content and activities of this workshop were based on the Unified Mindfulness system, which is noted for its fine grained and comprehensive dimensional analysis of mindfulness practice (for details see Young, 2016).

During the six-week intervention period, HDMT participants viewed a didactic video series that described the principles of the Unified Mindfulness System and also complete daily 25-minute guided audio practice sessions for five days each week. Daily home practice consisted of recordings from the senior mindfulness instructor. Participants were given a range of practices to choose from that guided their attention to: visual experiences includes mental image, physical sight, visual rest, visual flow and/or visualizing positivity; auditory experience includes mental talk, physical sound, auditory rest, auditory flow and/or positive self-talk; and somatic experiences including emotional body sensations, non-emotional body sensations, restful states (such as relaxation), physical flow and/or emotional positivity. Home practice audios recordings were hosted on a commercial web platform which tracked the duration of time that participants spent listening to the recordings each day. These timestamps were used to assess participant compliance with home practice during the intervention period.

During the intervention period, HDMT participants also participated in weekly group conference calls where they could ask questions, offer reports, and receive additional didactic instructions for applying mindfulness techniques to daily life activities. Finally, participants received an optional 15-minute individual phone meeting with the mindfulness instructor in order to discuss their experiences with the training program.

Measures

Perceived stress was assessed as part of the baseline and post-intervention battery of questionnaires. Momentary stress, coping, and affect were assessed via beeped assessments four times daily for three days before and three days after the intervention. See Table 2 for specific items used to assess each construct. Please note that the baseline and post-intervention questionnaire batteries and beeped assessments also included additional measures which were either exploratory in nature or will be described in other manuscripts.

Perceived Stress.—Perceived stress was measured using the 10-item Perceived Stress Scale (PSS; Cohen & Williamson, 1988). The PSS asks participants to rate how often they find their lives to be unpredictable, uncontrollable, and overloaded on a five-point scale ranging from 0 (*never*) to 4 (*very often*). Responses were coded so higher scores indicated greater perceived stress, then summed to create an index of total perceived stress (average α=.87; average α was calculated by averaging reliability values computed at each time point).

Stress and Coping Efficacy.—To assess stress since previous assessment, participants were asked to provide a single stress rating indicating how much stress they were experiencing or feeling right now on a seven-point Likert scale with anchors at 1 (*mild*), 4

(*moderate*), and 7 (*severe*). Participants were also asked to provide a single yes/no response indicating whether they had experienced any feelings of stress since the previous assessment. Participants indicating that they had experienced stress since the previous assessment were asked three additional questions assessing stressor severity, amount of time stressed, and success of coping. Stressor severity was assessed by asking participants how severe their experiences of stress were since the previous assessment on a seven-point Likert scale from 1 (*mild*) to 7 (*severe*) with a midpoint of 4 (*moderate*). Amount of time stressed was assessed by asking participants to estimate the proportion of time they felt stressed since the previous assessment on a seven-point Likert scale from 1 (*very little, 0–10%*) to 7 (*almost the entire time, 90–100%*). Coping success was assessed by asking participants to indicate how successful they were in coping with stress since the previous survey from 1 (*not at all*) to 7 (*extremely*).

Affect.—Two items were used to assess momentary affect at each assessment. Participants were asked to rate how positive/negative they felt immediately before beginning the survey on a seven-point Likert scale from 1 (*not at all*) to 7 (*extremely*).

Data Analyses

To assess changes in perceived stress, 2-level multilevel models were used to test for Time (baseline, post-intervention) x Condition (HDMT, LDMT) differences using Stata's *mixed* command. In 2-level models, observations (Level-1) are nested within individuals (Level-2). To test experience sampling predictions, 3-level multilevel models were used to test for Time x Condition differences using Stata's *mixed* command. For the sole binary outcome (stress since previous assessment), the *melogit* command was used to conduct a multilevel mixedeffect logistic regression. In 3-level models, beeped assessment observations (Level-1) are nested within days (Level-2) which are nested within individuals (Level-3). Restricted maximum likelihood estimation with an identity covariance matrix was used for all multilevel mixed effect linear regressions. An unstructured random-effects covariance matrix was used for multilevel logistic regressions. The term of interest in all models was the Time x Condition interaction because this term indicates whether changes in each outcome over time differ by condition (HDMT or LDMT).

Although multilevel models for longitudinal studies typically include an autoregressive term (ρ) to account for serial autocorrelation between proximal observations, we were unable to do so here because the continuous term for time since study onset was collinear with the categorical predictor for time (baseline, post-intervention). The nesting of observations within days in our 3-level models accounts for autocorrelation between consecutive measurements. We also elected to take a conservative approach by including a fixed-effect term in the model for observation number of the day. Examination of the residuals produced from the specified model indicates that these steps were generally successful in detrending the data.

In summary, predictions about changes in perceived stress followed the 2-level equation below:

Level 1:

$$\text{Stress} = \beta_{0j} + \beta_{1j}{}^{*}(\text{Time}) + r_{ij}$$

Level 2:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Condition}) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Condition})$$

Experience sampling predictions were tested using the general 3-level equation below:

Level 1:

$$\text{Stress} = \pi_{0jk} + \pi_{1jk}{}^{*}(\text{TimeOfDay}) + e_{ijk}$$

Level 2:

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}(\text{Time}) + r_{0jk}$$

$$\pi_{1jk} = \beta_{10k}$$

Level 3:

$$\beta_{00k} = \gamma_{000} + \gamma_{001}(\text{Condition}) + u_{00j}$$

$$\beta_{01k} = \gamma_{010} + \gamma_{011}(\text{Condition})$$

$$\beta_{10k} = \gamma_{100}$$

Results

First, success of randomization on major demographic characteristics was evaluated using the full randomized sample (N=60). There were no baseline differences between groups in age, sex, or race indicating that randomization was successful (see Table 3). Next, we assessed participant compliance with the ecological momentary assessment sampling

procedures. The maximum possible number of completed beeped assessment responses was 1440 (60 participants x 6 days of assessments x 4 beeped assessments daily). The actual number of beeped assessments completed was 830 (57.6% of all possible assessments). The median number of beeped assessments completed was 14. Using a median split of experience sampling compliance, there were no age, race, or sex differences between those who were high or low in ecological momentary assessment sampling adherence (all *ps*>.514). Finally, we assessed adherence to the study intervention among HDMT participants (LDMT participants were not assigned home practice). HDMT participants were asked to complete a total of 750 minutes of mindfulness meditation home practice during the intervention period (25 minutes daily x 5 days per week x 6 weeks), and completed 303.07 minutes (*SD*=236.11; median=247) on average. There were no demographic differences between those high and low in home practice compliance (all *ps*>.100). Including minutes of home practice as a person-level covariate (with a value of 0 for LDMT participants) in all primary analyses did not change any of the results reported below.

Number of stressors experienced

We hypothesized that HDMT and LDMT participants would not differ in change in the number of stressors they experienced from baseline to post-intervention. To test this hypothesis, we used 3-level multilevel models to evaluate the Time x Condition interaction. Consistent with the high stress context in which this study took place, participants reported experiencing feelings of stress since the previous survey at nearly half of all beeped assessments (*n*=405; 48.8%). However there was no main effect of condition across time points ($\chi^2(1)<0.01$, $p=.969$), no main effect of time across conditions ($\chi^2(1)=0.97$, $p=.325$), and no interaction between time and condition in the number of stressors experienced since last assessment ($\chi^2(1)=0.36$, $p=.547$, $d=.16$). These preliminary analyses were consistent with expectations and indicate that while all participants experienced high levels of stress overall, the number of reported stressors experienced did not differ between groups or change significantly over time.

Perceived Stress

We predicted that HDMT would reduce perceptions of overall stress during the past month (as measured by the PSS) from baseline to post-intervention relative to LDMT participants. (Note that this PSS measure was collected at baseline and post-intervention and is not an EMA measure.) To test this, we used 2-level multilevel models to evaluate the Study Condition x Time interaction. There were six participants who did not complete the post-intervention questionnaire battery (*n*=6). Thus, only 114 of 120 possible measurements (95.0%) were included in this set of analyses. There was no main effect of condition across time points ($\chi^2(1)=0.15$, $p=.694$), a marginal main effect of time across conditions ($\chi^2(1)=3.81$, $p=.051$), and consistent with predictions, an interaction between time and condition ($\chi^2(1)=5.16$, $p=.023$, $d=.52$). HDMT participants decreased in perceived stress from baseline (*M*=28.00, *SE*=1.11) to post-intervention (*M*=25.01, *SE*=1.13; mean change=−2.99, $p=.002$, $d=.48$), while LDMT participants did not change in perceived stress from baseline (*M*=26.97, *SE*=1.14) to post-intervention (*M*=27.19, *SE*=1.20; mean change=.226, $p=.827$, d=−.04) (see Figure 2a).

Momentary Stress Perceptions

Although HDMT and LDMT participants did not differ or change over time in the number of stressors they reported experiencing, we tested the prediction that HDMT participants would decrease in momentary stress perception ratings from baseline to post-intervention relative to LDMT participants. To test this, we used 3-level multilevel models to evaluate the Time x Condition interaction. There was no main effect of condition across time points ($\chi^2(1)=0.08$, $p=.774$) and no main effect of time across conditions ($\chi^2(1)=0.08$, $p=.783$). Consistent with initial predictions, there was an interaction between time and condition ($\chi^2(1)=6.03$, $p=.014$, $d=.52$). While LDMT participants marginally increased in momentary stress from baseline ($M=2.49$, $SE=.17$) to post-intervention ($M=2.75$, $SE=.18$; mean change = .258, $p=.0613$, $d=-.275$), while HDMT participants slightly decreased in momentary stress from baseline ($M=2.66$, $SE=.16$) to post-intervention ($M=2.45$, $SE=.18$; mean change = −.206, $p=.114$, $d=.224$) (see Figure 2b).

Coping Efficacy

Although the number of stressors HDMT and LDMT participants reported experiencing did not change from baseline to post-intervention, we hypothesized that HDMT participants would have lower stress severity ratings and time stressed, as well as increases in coping efficacy when stressors did occur. Of the 405 observations where participants reported experiencing stress since the previous assessment, there were two observations where follow-up items were left blank ($n=2$; 0.5%). Thus, only the remaining 403 observations were included in this set of analyses.

For coping efficacy, there was no main effect of condition across time points ($\chi^2(1)=0.67$, $p=.414$), no main effect of time across conditions ($\chi^2(1)=1.61$, $p=.205$), and consistent with predictions, an interaction between time and condition ($\chi^2(1)=7.57$, $p=.006$, $d=.74$). While LDMT participants increased in proportion of time stressed from baseline ($M=2.67$, $SE=.18$) to post-intervention ($M=3.19$, $SE=.21$; mean change = .528, $p=.006$, $d=-.49$), HDMT participants were buffered against this increase and did not change from baseline ($M=2.84$, $SE=.17$) to postintervention ($M=2.64$, $SE=.19$; mean change = −.193, $p=.284$, $d=.20$).

For stressor severity, there was no main effect of condition across time points ($\chi^2(1)=2.10$, $p=.147$), no main effect of time across conditions ($\chi^2(1)=1.51$, $p=.219$), and a marginally significant time by condition interaction ($\chi^2(1)=3.70$, $p=.055$, $d=.55$). While LDMT participants increased in reported stressor severity from baseline ($M=3.45$, $SE=.18$) to post-intervention ($M=3.88$, $SE=.21$; mean change = .432, $p=.031$, $d=-.41$), HDMT participants were buffered against this increase and did not change in reported stressor severity from baseline ($M=3.38$, $SE=.17$) to post-intervention ($M=3.29$, $SE=.19$; mean change = −.093, $p=.620$, $d=.09$).

For coping success, there was no main effect of condition across time points ($\chi^2(1)=0.26$, $p=.612$), but there was a main effect of time across conditions ($\chi^2(1)=5.94$, $p=.015$). This was qualified by an interaction between time and condition ($\chi^2(1)=4.80$, $p=.028$, d=.66). While LDMT participants decreased in coping success from baseline ($M=4.07$, $SE=.17$) to post-intervention ($M=3.44$, $SE=.20$; mean change = −.626, $p=.002$, $d=-.64$), HDMT

participants were buffered against this decrease and did not change in coping success from baseline (*M*=3.88, *SE*=.16) to postintervention (*M*=3.84, *SE*=.18; mean change = −.036, *p*=.846, *d*=−.04).

Momentary Affect

We predicted that HDMT participants would increase in positive affect and decrease in negative affect during working hours from baseline to post-intervention relative to LDMT participants. To test this, we used 3-level multilevel models to evaluate the Time x Condition interaction. Of the 830 completed assessments, 38 did not assess momentary affect due to problems with the software platform. Thus, only the remaining 792 observations were included in this set of analyses. For momentary positive affect, there was no main effect of condition across time points ($\chi^2(1)=0.04$, $p=.832$) and no main effect of time across conditions ($\chi^2(1)=1.05$, $p=.307$). However, there was an interaction between time and condition ($\chi^2(1)=6.84$, $p=.009$, d=.55). While LDMT participants decreased in momentary positive affect from baseline (*M*=4.56, *SE*=.16) to post-intervention (*M*=4.24, *SE*=.17; mean change = - .324, *p*=.014, *d*=−.36), HDMT participants were buffered against this decrease and did not change in positive affect from baseline (*M*=4.37, *SE*=.15) to post-intervention (*M*=4.51, *SE*=.16; mean change = .141, *p*=.242, *d*=.16) (see Figure 3). For momentary negative affect, there was no main effect of condition across time points ($\chi^2(1)=2.19$, $p=.139$) but there was a main effect of time across conditions ($\chi^2(1)=17.53$, $p<.001$). This was qualified by an interaction between time and condition ($\chi^2(1)=5.48$, $p=.019$, $d=.58$). While LDMT participants increased in negative affect from baseline (*M*=1.99, *SE*=.13) to post-intervention (*M*=2.54, *SE*=.15; mean change = .553, *p*<.001, *d*=−.74), HDMT participants were buffered against this increase and did not change in negative affect from baseline (*M*=1.94, *SE*=.12) to post-intervention (*M*=2.09, *SE*=.14; mean change = .158, *p*=.169, *d*=−.21) (see Figure 3).

Discussion

This RCT provides evidence that six weeks of mindfulness training can improve multiple measures of well-being at work. Consistent with predictions, HDMT participants decreased in both momentary stress and overall perceived stress. HDMT participants were also buffered against worsened affect and decreases in coping efficacy observed among LDMT participants. One particularly novel feature of this study is the use of EMA measures administered during the workday to assess study outcomes. Though previous investigations have suggested that mindfulness interventions may improve worker well-being (e.g., Aikens et al., 2014; Shonin, Gordon, Dunn, Singh, & Griffiths, 2014; Wolever et al., 2012), these studies have tended to rely on global retrospective self-report measures to evaluate outcomes. The use of such measures can introduce sources of bias that limit accuracy (Nisbett & Wilson, 1977). The use of EMA in the present study is advantageous because it allows for dynamic processes such as stress, coping, and affect to be captured in real time as they unfold during the workday (Shiffman et al., 2008; Smyth & Stone, 2003).

It is particularly notable that HDMT was associated with reductions in both overall perceived stress and momentary stress ratings during the workday. While previous studies

have shown that mindfulness training can reduce global perceptions of life stress (Aikens et al., 2014; Shonin et al., 2014; Wolever et al., 2012), this RCT demonstrates that mindfulness training can also decrease stress assessed in the workplace during the workday. Additionally, one important contribution of this research is that it provides evidence that the effects of mindfulness training on stress within an organizational setting are dose-dependent.

Another important contribution of this study is that it compares the effects of a high-dose mindfulness-based training to that of a low-dose mindfulness training in a for-profit workplace using a randomized controlled trial design. This approach is especially advantageous because it provides a systematic examination of the dose-response effects of mindfulness training. One potentially surprising finding was that LDMT was actually associated with decreased worker well-being. One possible reason for this is that as noted previously, this study examined employees of a digital marketing firm that underwent a period of significant organizational change and restructuring during the intervention period. It is therefore possible that any relative benefits of HDMT are actually attributable to stress-buffering rather than direct effects. Consistent with this possibility, HDMT participants were buffered against increases in momentary negative affect, decreases in momentary positive affect, and decreases in coping efficacy experienced by LDMT participants; HDMT participants did not improve significantly in any of these outcomes from baseline to post-intervention. However HDMT was associated with reductions in both overall perceived stress and momentary stress, suggesting that HDMT conferred direct benefits that were not observed in the LDMT group. Another possible reason that LDMT was associated with decreased worker well-being is that continued daily mindfulness practice may be particularly important for reducing momentary stress in a high stress work environment. This possibility is consistent with earlier work examining the dose-response effects of mindfulness interventions in patient populations which found that a single-day mindfulness seminar was associated with negative health impacts among a patient sample (Creswell et al., 2009). Similarly, it is possible that LDMT in this study was insufficient for reducing the increased stress associated with a workplace experiencing significant change and restructuring.

Overall, these stress buffering effects are consistent with previous theoretical accounts of how mindfulness interventions may impact health outcomes (Creswell & Lindsay, 2014). Given popular interest among corporations in low dose mindfulness programs, these results suggest that several hours of mindfulness training (in a single low dose seminar) is insufficient for stress buffering benefits in the workplace. As such, these findings may be particularly useful for facilitating the design of more efficient and efficacious workplace interventions (Carmody & Baer, 2009; Creswell, 2017). This is especially important given that numerous companies currently design and offer mindfulness training programs in the absence of sufficient empirical evidence (Gelles, 2015).

Limitations and Future Research

There are several limitations of the present study. First, this RCT was conducted in a small digital marketing company and so the sample size is relatively small. However, it is important to acknowledge that the use of EMA and multilevel analyses allows for the use of

all available data and therefore provides greater statistical power compared to more traditional pre- and post-treatment assessments (Raudenbush & Bryk, 2002). Second, it would have been optimal to conduct a three-arm RCT comparing HDMT to both LDMT and to an assessment only control group. This approach would have helped clarify the benefits of LDMT compared to a no treatment control group, but given the small sample size this three-arm study approach would have been underpowered. Third, an additional limitation of this study was that stress and well-being were measured exclusively using self-report. Although the EMA sampling approach used here is thought to minimize many of the biases associated with self-reporting (e.g., Stone & Broderick, 2007), future studies should seek to replicate these effects using objective measures such as performance or sick days. Additionally, the EMA items used to assess stress, coping, and affect were adapted from available trait inventories, but have not been extensively tested or validated. Future studies are also needed both to establish the psychometric properties of the measures used in this study and to replicate these findings using previously validated measures. Fourth, the individuals examined in this study were predominantly white (95% white) which may limit the generalizability of these findings to more diverse organizations. Future research should seek to replicate these results in more diverse samples.

Finally, one novel feature of this study was the evaluation of compliance with home practice among HDMT participants. Although the use of timestamps to assess home practice compliance was a unique strength of this study, this approach did not provide a sufficiently detailed or accurate picture of engagement with home practice among HDMT participants. Moreover, potential home practice among LDMT participants was not probed at study completion. Future studies should consider the importance of developing more objective and accurate means of tracking the nature and extent of participant home practice. Future research is also needed to compare the efficacy and feasibility of the mindfulness training program used in this study to that of other programs such as 8-week MBSR.

This study demonstrates the efficacy of a workplace mindfulness interventions for improving employee well-being. Employees who completed a high-dose six-week mindfulness intervention decreased in both momentary and perceived stress, and were buffered against worsened affect and decreased coping efficacy observed among employees completing a low-dose single-day mindfulness workshop. This adds to a growing body of anecdotal (Kachan et al., 2017; Seppala, 2015) and empirical evidence (Good et al., 2016; Roche et al., 2014) suggesting that mindfulness may be one useful tool for improving employee well-being. The results of the current investigation underscore the need for future studies in this area to more closely consider issues of dosing effects and worker wellbeing benefits.

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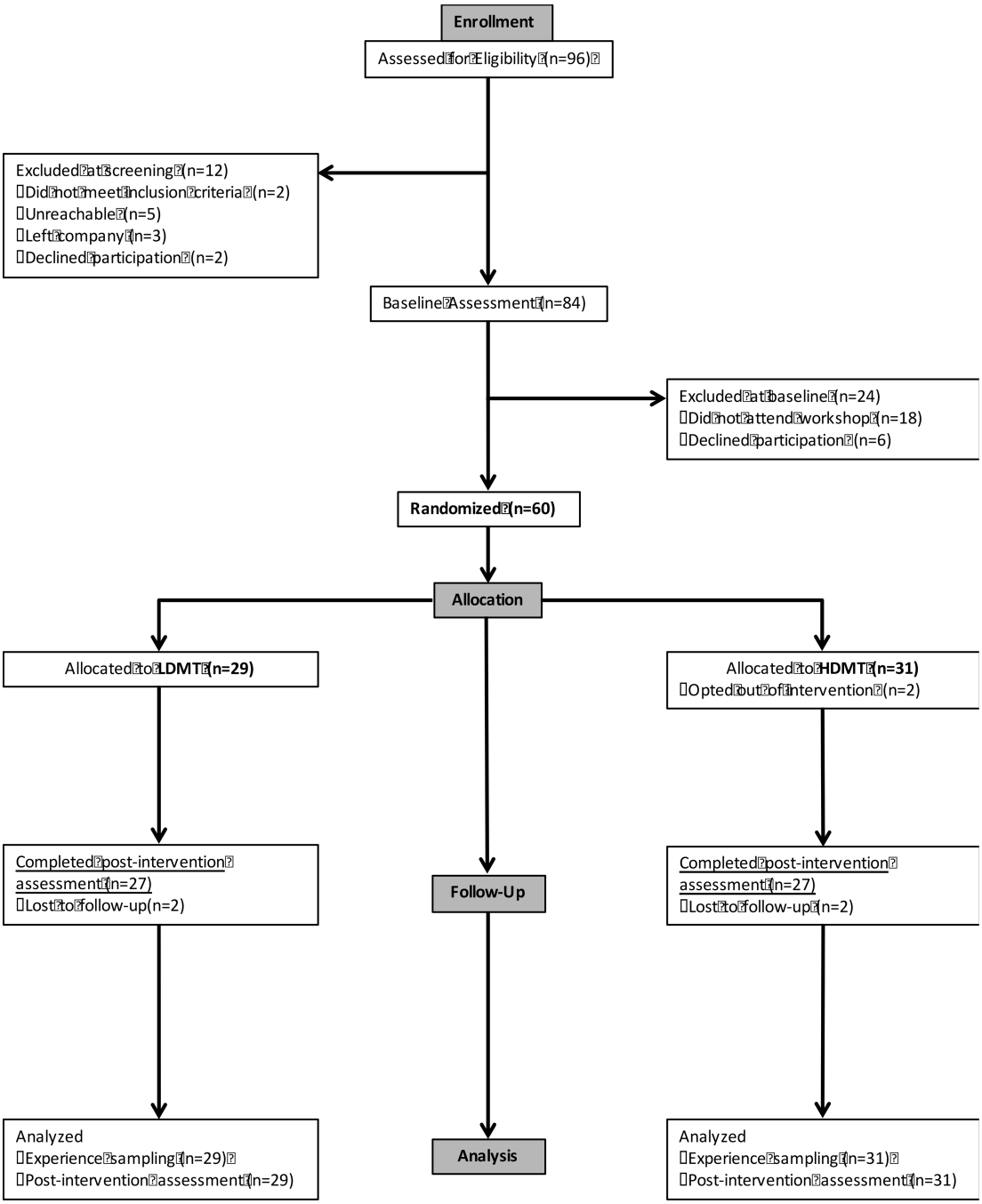

Figure 1.
CONSORT flow chart.

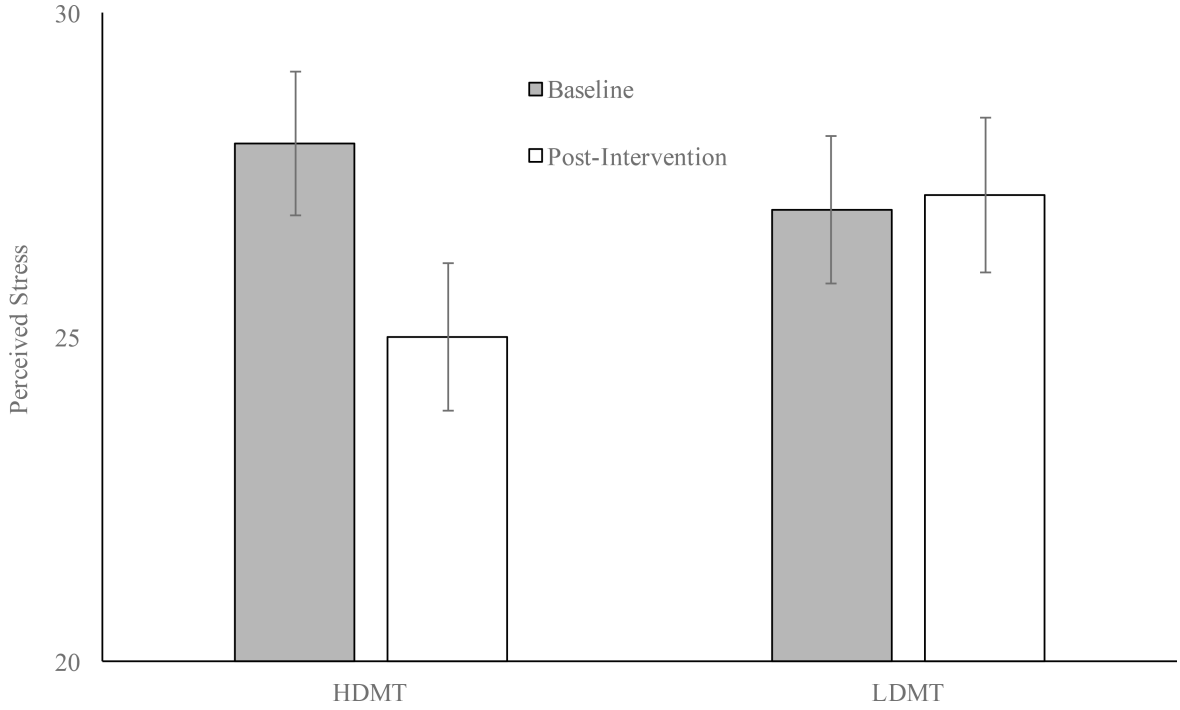

Figure 2a.
Perceived stress at baseline and post-intervention by study condition.

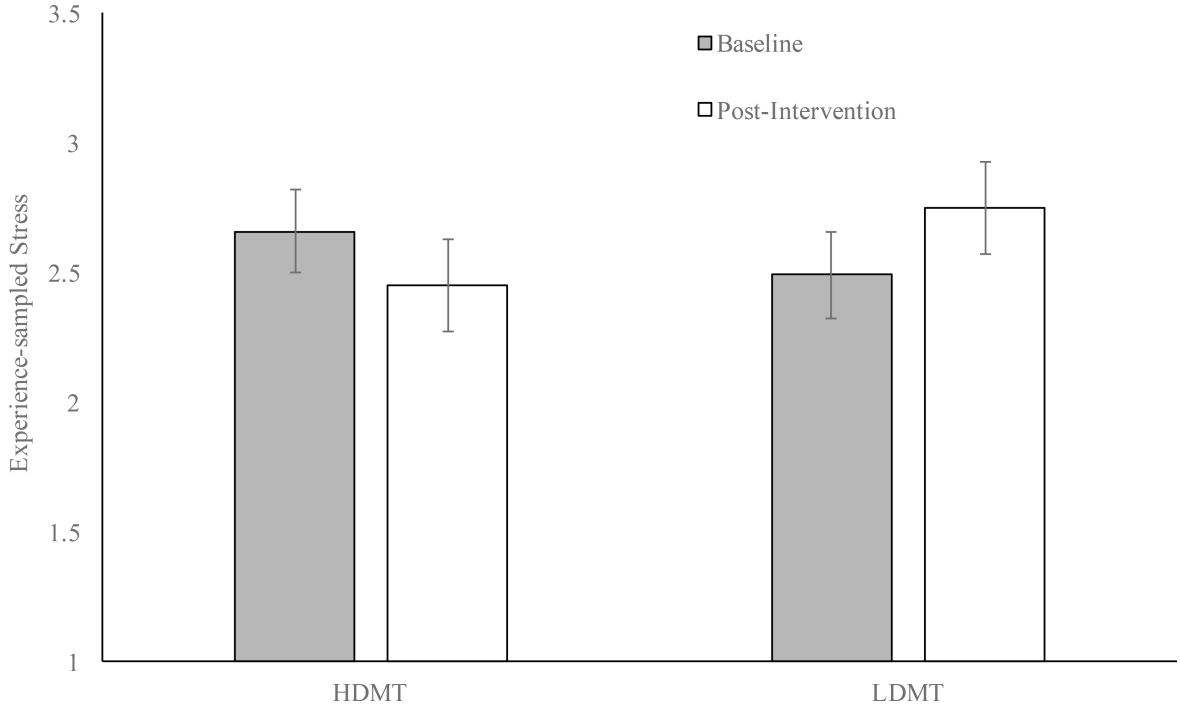

Figure 2b.
Experience-sampled stress at baseline and post-intervention by study condition.

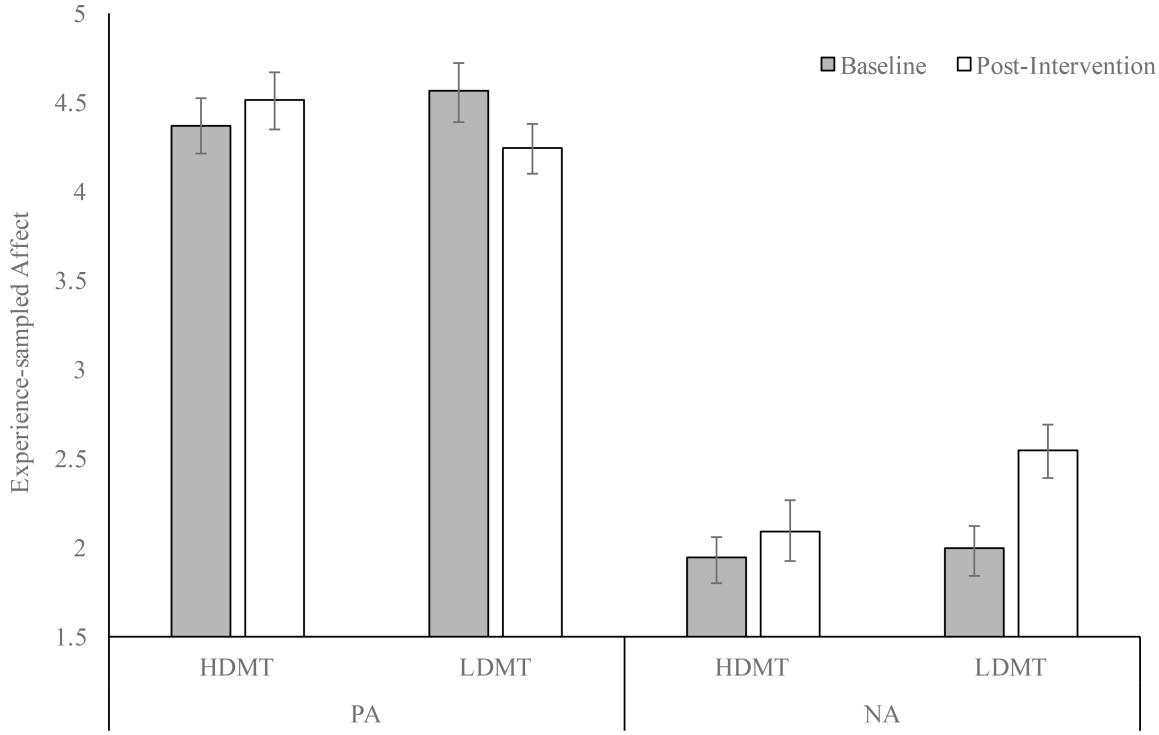

Figure 3.
Experience-sampled affect at baseline and post-intervention by study condition.

Table 1.

Timeline of study activity

Time	Study Activity
Week -2	Online eligibility prescreening
	Informed consent
	Baseline questionnaires and tasks
Week -1	Three days of baseline experience sampling and daily diary assessments
Week 0	4-hour in-person mindfulness workshops
	Randomization to HDMT or LDMT
Weeks 1–6	HDMT: Viewed didactic video series, completed guided audio practice sessions, participated in weekly conference calls with instructor, completed individual phone meeting with instructor
	LDMT: No additional mindfulness instruction
Week 7	Three days of post-intervention experience sampling and daily diary assessments
Week 8	Post-intervention questionnaires and tasks
	Debriefing

Table 2.

Items used to assess momentary stress, coping, and affect.

Constructs	Item
Stress and Coping	
1. Stress Ratings	How much stress are you experiencing or feeling right now?
2. Stress Since Previous	Did you experience any feelings of stress in the time since you completed the last survey?
3. Stressor Severity	How severe was your experience of stress since the last survey?
4. Stress Time	Since the last survey, how much of the time were you feeling stressed?
5. Successful Coping	How successful were you in coping with stress since the last survey?
Affect	
1. Positive Affect	Just before this survey, how positive was your emotional state or mood?
2. Negative Affect	Just before this survey, how negative was your emotional state or mood?

Table 3.

Baseline characteristics of randomized participants by condition (N=60)

	HDMT (*n*=31)	LDMT (*n*=29)	Difference Statistic
Age	30.87 (8.87)	30.14 (6.61)	$F(1,58)=.130$, $p=.719$
Sex			$\chi^2(1)=.534$, $p=.465$
Male	9 (29.0%)	11 (37.9%)	
Female	22 (71.0%)	18 (62.1%)	
Race			$\chi^2(1)=2.954$, $p=.086$
White	28 (90.3%)	29 (100.0%)	
Non-White	3 (9.7%)	0 (0.0%)	

Notes. For binary or categorical variables (i.e., sex and race), numbers inside parentheses represent percentage of sample. For continuous variables (age), numbers inside parentheses represent standard deviations. Randomization was successful for all demographic variables.

Of the 60 participants randomized, 6 dropped out before study conclusion (10.0%). Those who dropped out did not differ in age, $F(1,134)=.112$, $p=.740$, sex, $\chi^2(1)=.833$, $p=.361$, or race, $\chi^2(1)=.351$, $p=.554$.