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Adherence to Practice of Mindfulness in Novice Meditators: Practices Chosen, Amount of Time Practiced, and Long-Term Effects Following a Mindfulness-Based Intervention

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Abstract

In this study, we objectively tracked the duration, frequency, and the preferred practices chosen by novice mindfulness practitioners following a mindfulness meditation (MM) intervention. A sample of 55 mildly stressed participants, aged 50 to 80 years old, underwent an individual 6-week MM intervention and had their guided meditation home practice electronically recorded during the intervention and the 8-week post-intervention period. Participants' psychological well-being was assessed through self-report measures of mindfulness, quality of life, and symptoms of depression and stress. Results evidenced a high adherence to practice, with an average of ~23 minutes per day during the intervention and ~16 minutes per day in the follow-up period. Body scan, sitting meditation, and breathing space were the most popular meditation practices among participants. Our results showed significant alterations in self-reported measures over time, suggesting improvements in stress and overall quality of life. Changes in the self-report measures did not correlate with MM practice time, which suggests that other psychological phenomena, including quality of meditation practice, influence these outcomes.

Keywords

Mindfulness; Adherence; Placebo effect; Formal mindfulness; Informal mindfulness

Introduction

The past and current decades have been marked by a boom of research exploring the effects of mindfulness-based interventions (MBI) on inexperienced meditators within different populations. Studies have shown improvements in cognition, affect, and reductions in

Author Contributions

LR: analyzed and interpreted the data and wrote the paper. RA: collaborated with the design, performed the data analyses and contributed with the paper's editing. BO: designed and executed the study, assisted with the data analyses, and supervised the writing of the paper.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

general negative symptoms both physical (Rosenzweig et al. 2010; Sephton et al. 2007; Pradhan et al. 2007) and psychiatric (Baer 2003; Chiesa and Serretti 2011; Fjorback et al. 2011; Hofmann et al. 2010; Khoury et al. 2013), suggesting these interventions to be highly effective.

Mindfulness is generally described as purposeful nonjudgmental attention to the present moment (Kabat-Zinn 2005). According to its Buddhist roots, mindfulness is an active and investigative process involving several different human aspects such as cognition, attitude, and affect as well as social and ethical dimensions (Grossman 2010; Tang et al. 2015). Following these traditions, it is assumed that mindfulness skills rely on the experience of the practitioner, being developed through time and effort (Kabat-Zinn 2005). Therefore, adherence to daily practice is key in building a skilled, mindful mind (Grossman 2011). In the long term, the development of these skills also promotes psychological well-being, leading to higher levels of resilience (Keune and Forintos 2010; Oken et al. 2015), which improves coping with physical and emotional problems (Bowen et al. 2010; Segal et al. 2010).

Evidence relating regular meditation practice with higher levels of mindfulness and other health-related measures following MBIs have been widely reported (Carlson and Garland 2005; Miller et al. 1995; Ong et al. 2009). For instance, Sephton et al. (2007) investigated the effects of the mindfulness-based stress reduction (MBSR) program with fibromyalgia patients. They reported that participants who often practiced mindfulness at home significantly reduced their somatic and depression symptoms post-intervention. Patients with chronic pain reported to practice an average of 20 min per day, 6 days per week during an MBI program and it was significantly correlated with the reduction in pain perception and general health improvements (Rosenzweig et al. 2010). Effects of long-term adherence to the practice of mindfulness have also been reported, revealing sustained improvements after follow-up periods. A study investigating the effect of an MBI with cancer patients after a 6-month follow-up yielded significant correlations between the home practice during this period and psychological improvements, such as acceptance towards the illness (Carlson and Garland 2005). In another study, a CBT-based mindfulness intervention targeting insomnia, participant’s symptoms improved at the 12-month follow-up and were positively correlated with individual amounts of mindfulness practice during this period. Authors considered the amount of practice recorded in a self-report daily log during the previous week as a measure of the sample’s overall practice within the past year (Ong et al. 2009). In a 3-year follow-up study of individuals diagnosed with anxiety disorders, 56% of the participants kept regular meditation practice and improvements in symptoms were maintained at the same range as at the immediate post-treatment period. In this study, the amount of practice on average during the period was selfreported by participants and qualitatively classified by the authors (Miller et al. 1995).

Literature regarding the type of meditation practice, as for whether formal or informal, with respect to adherence and outcomes, has reported inconsistent results. A sample of patients with rheumatoid arthritis who underwent an MBSR program had their home practices tracked during the 8-week intervention (Pradhan et al. 2007). Results showed that a significant reduction in depressed symptoms and improvements in other psychological

measures were correlated with the practice frequency, but not with the type of practice (formal or informal). In contrast, Carmody and Baer (2008) observed different results when evaluating adherence in a clinical sample with varied symptoms following an MBSR program. Participants practiced an average of 31–35 min per day of formal practices and 11–15 min of informal practices (becoming mindful in everyday activities). The results show that only time spent on formal practices correlated with stress reduction and increased psychological well-being, and this effect was mediated by the increased self-perception of mindfulness. However, other findings reported that informal rather than formal practices were correlated with outcomes. In a study investigating the effect of MBSR on sleep disturbances in women with breast cancer, only the amount of informal practice correlated with sleep efficacy (Shapiro et al. 2003). The same results were found in a generalized anxiety disorder sample at 6- and 9-month follow-ups (Morgan et al. 2014), and on a smoking cessation clinical trial in which only the amount of informal practice moderated the correlation between craving and smoking, being negatively correlated with the number of cigarettes per day (Elwafi et al. 2013).

Although research generally points positive correlations between practice frequency and outcomes, the absence of correlations has also been reported, indicating that further investigation is needed regarding the influence of adherence to mindfulness practice on positive outcomes following interventions. Dobkin and Zhao (2011) investigated the effects of MBSR in a mixed health conditions clinical sample finding significant improvements in mindfulness and other health-related measures among participants. The sample presented high levels of attendance to class and reported frequent home practice, however, neither the type nor the quantity of daily mindfulness practice was associated with clinical outcomes. One possible explanation for this result is the use of self-report measures to assess both the health-related improvements and the adherence to practice. As self-report measures are subjective, it is possible that participant's expectation towards the practice played a role in their perception of improvements regardless of the amount of practice. Considering that the measurement of adherence to mindfulness was also not objectively measured, it is possible that participants may have overestimated their amount of home practice (Rosenzweig et al. 2010; Wahbeh et al. 2011).

The use of self-reports to track mindfulness adherence is one of the major issues in mindfulness research, limiting the understanding towards an optimum dose-response curve balancing practice and outcomes. The majority of studies are based on daily or retrospective logs to report the length and frequency of practices, which may result in inaccurate estimates. Wahbeh et al. (2011) reported differences in the self-perception of adherence comparing a subjective and an objective measure of the home practice of participants of an MBI program. In this case, participants were asked to report daily logs of practice (minutes/day) and also had their real amount of auditorily guided meditation practice recorded through software. Results showed that measures of subjective practice were higher than the real amount of time spent listening to the guided meditations. This result reinforces the limitation of self-reported adherence pointing to the need for more studies addressing objective measures of adherence.

Another important issue concerning the dose-response problem in mindfulness research is the lack of specific reports regarding the type of meditation practiced by participants. Most studies do not present descriptions of the kind of practices, other than generically informing the presence of formal and sometimes informal practices in the interventions. It is possible that specific practices (e.g., body scan) may be more fit to a particular set of outcomes than others, what would help the process of tailoring interventions, maximizing its effectiveness (Davidson and Kaszniak 2015). Also, the knowledge of the preferred practices among specific groups of MBI participants would facilitate the development of programs based on more suitable practices for these populations, increasing the likelihood of long-term adherence. Therefore, more information about types of practices in adherence reports is needed. With the aim of addressing the limitations of studies regarding participant's adherence to practice following MBIs, the present study focused on analyzing the duration, frequency, and practices chosen by novice mindfulness practitioners while comparing these variables with measures of self-perception of stress and quality of life.

Method

Participants

The present study is based on the analyses of the mindfulness adherence data collected from an RCT investigating the effects of an MBI on cognitive, general mental health, and stress-related physiology among mildly stressed older adults (Oken et al. 2017). A total of 134 participants were recruited from the Portland, Oregon metropolitan area between June 2011 and January 2015. People were reached in the local community using advertisements and announcements through newsletters and newspapers, email list servers and postings at Oregon Health & Sciences University (OHSU). The eligibility criteria consisted of being 50 to 80 years old, in generally good physical and cognitive health, and a minimum of moderate stress. Eligible participants were screened through a telephone interview lasting about 30 min and needed to score >9 on the perceived stress scale (PSS; Cohen et al. 1983). The interviews were conducted using an OHSU IRB-approved waiver of authorization and signed consent was obtained at the first in-lab visit.

Exclusion criteria aimed to exclude those with conditions that would confound cognitive or physiological outcome measures or increase the likelihood of dropouts considering the targeted population: significant cognitive impairment evidenced by achieving a score <30 on the modified telephone interview for cognitive status (TICS-m; Knopman et al. 2010) or significant participant complaint; self-reported medical condition and chronic illnesses such as diabetes or active cancer; untreated depression; or use of medications known to affect cognition or physiologic measures (e.g., regular narcotic analgesics). Previous experience with meditation or any other mind-body interventions classes (e.g., yoga) within the past 24 months was also an exclusion criterion.

Procedures

Design

Participants were either waitlisted or underwent a 6-week one-on-one mindfulness meditation (MM) protocol. The individual intervention is standardized and was chosen to facilitate the research flow as the formation of groups, especially among older adults' populations, can be challenging (Wahbeh et al. 2014). All participants enrolled in data collection visits at baseline (V1) at week 0, visit 2 (V2) at week 7 and visit 3 (V3) at week 14. The MM group received training between visits 1 and 2 and continued to practice on their own between visits 2 and 3. The waitlist control group was given no instructions between visits 1 and 2 and then received the 6-week MM training between visits 2 and 3. As the aim of this paper was the tracking of adherence to mindfulness practice and its relationship to health-related outcomes, no analyses were provided towards the control group. A brief description of changes in post-intervention measures, when compared to baseline among controls, is provided in the Results section. Further information pertaining the full analysis comparing intervention and control groups can be found in the main outcomes paper (Oken et al. 2017).

Randomization Process

Randomization was performed using a computerized covariate adaptive randomization procedure (Pocock and Simon 1975). The procedure aimed at matching the groups on age, gender, and baseline PSS scores using a pre-determined projected median split for the continuous measures. Both randomization and data collection visits were conducted by research personnel blind to group assignment. Out of the 134 total participants randomized, 66 were randomized to receive the MM immediately after randomization, of which 58 completed the three visits. As previously mentioned, the present study is focused on the analysis of the mindfulness practice among the intervention group during MM training and the follow-up period.

Measures

The full RCT included cognitive, self-report, and physiological measures of stress (salivary cortisol, blood pressure, and heart rate variability). The cognitive and physiological data are outside the scope of our current analyses. Therefore, specifics of methodology and results concerning the collection of these data are not presented in this paper (more information can be found in Oken et al. 2017). The self-report questionnaires were sent to participants through a packet in the mail about 1 week prior to each lab visit. The self-report measures are described as it follows.

Neuroticism

Since previous studies have reported that mindfulness can significantly impact personality traits such as neuroticism and conscientiousness (Giluk 2009), and because personality traits may impact adherence, participants were asked to fill the NEO-FFI personality inventory, a 60-item, 5-point Likert scale with 5 factors. In this study, we will be only presenting the

results for the neuroticism (α = .68) and conscientiousness (α = .85) factors, both with 12 items each (Costa and McCrae 1992).

Perceived Stress

The PSS was used to measure participants' perception of stress by querying to what extent they perceive their lives as unpredictable, uncontrollable, or how much they feel overwhelmed by current life (Cohen et al. 1983). Scores can vary from 0 to 40, where higher scores indicate higher levels of stress. The instrument consists of a self-report scale with ten items divided into two factors: coping and distress. The coping factor assesses levels of perceived self-efficacy, while the distress measures levels of helplessness. The total internal consistency is good, with a reported Cronbach's alpha of 0.76 (Cohen et al. 1983; Lee 2012).

Expectancy and Credibility

To measure possible placebo or minimizing effects of the intervention in the sample due to either a lack of or high expectancy of results, we administered the credibility/expectancy questionnaire. This instrument is a 6-item, 9-point Likert scale that assesses participants' expectancy and credibility towards treatments. Reports demonstrate good internal consistency for both subscales: expectancy with a Cronbach's alpha of 0.82 and credibility, with α = 0.75 (Devilly and Borkovec 2000).

Mindfulness

The ability to be attentive and to attend to the present moment was measured with the mindfulness attention awareness scale (MAAS). The MAAS is a 15-item, 5-point self-report scale, with strong internal consistency (α = 0.82), in which everyday levels of mindfulness attention are assessed (Brown & Ryan, 2003).

Quality of Life

A general measure of quality of life was obtained with the short-form health survey (SF-36). We accessed the impact of mindfulness using the scores of the physical and mental health component subscale, a health-related measure of quality of life (McHorney et al. 1993).

Affect

The Center for Epidemiologic Studies Depression Scale (CESD) was used as a measure of negative affect. This instrument is a 20-item, 4-points Likert scale exploring the presence of feelings of sadness, boredom, and other depression-related symptoms within the past week. The scale has strong internal consistency with Cronbach's alpha ranging from 0.88 to 0.91 being reported (Radloff 1977).

MM Training

The 6-week individual mindfulness protocol consisted of a standardized protocol based on mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR) as a one-on-one intervention compatible with research settings (Wahbeh et al. 2014). The protocol consists of a 6-week mindfulness meditation curriculum with 60–90-

min weekly meetings, which were conducted by a facilitator to guide participants through their weekly in-lab practice and recommend daily take-home practices. The meetings are generally focused on three basic components: (1) brief instructions about stress, meditation, and mind-body interaction; (2) mindfulness exercises practiced both in-session and daily at home; and (3) problem-solving techniques regarding successes and difficulties in practicing and applying the exercises in daily life (for details see Wahbeh et al. 2014). Sessions varied in time according to the topic and participant characteristics. For home practice, participants were advised to try to do at least some practice every day, with a goal of 30 to 45 min. Interventions started after V1 for all participants assigned to the MM group. Halfway through the study, aiming to address feedback from participants, a slight change was made in the intervention's curriculum, and three new meditations practices focused on the development of self-compassion were added to the syllabus for both in-lab and home practice. Participants enrolled in the study after the change received the modified intervention. No other changes were made. A full list of mindfulness practices in the syllabus can be found in Table 1 (see also Wahbeh et al. 2014 for further details).

Adherence to Meditation Practice

Adherence was tracked with the use of iMINDr; a software application developed to record participants' home practice (Wahbeh et al. 2011, 2014). An iPod Touch (Apple, Inc.) with installed software that records the frequency and length of the practices was lent to participants for the period of the study. Together with a brief introduction of mindfulness, each device had practice options varying from formal mindfulness, such as sitting meditation and body scan, to breathing space, an informal practice. The specific subject and length of each practice can be seen in Table 2.

Data Analyses

Self-report scores were calculated as the average score per participant on each specific scale. These scores were grand-averaged to obtain mean group scores on each of the three visits. We considered three variables for adherence: duration, frequency, and type of meditation chosen. For the duration, we took the average of total MM minutes practiced per participant per day and averaged them for the group. Frequency was taken by the percent of days of listened meditation considering total days from V1 to V2 and V2 to V3 as totals. Preferred practices were calculated considering the percent of time spent on each practice with the total time practiced per participant as totals and averaged within participants. Simple change scores in each of the self-report measures were compared across the three visits through a repeated measures ANOVA. Linear regressions were performed to verify the influence of the type of meditation on adherence (average total time practiced) and the effect of the expectancy levels on adherence. The same analyses were performed to assess the influence of sex, age, and personality traits (neuroticism and conscientiousness) on outcomes (in % change scores). We also ran multiple regressions, one to verify the effects of the different types of meditation on the psychological outcomes (in % change scores), and another to verify the effect of different amounts of practices on outcomes (in tertiles). All analyses were conducted using the IBM SPSS Statistics package version 22, with a significance level set at $p < 0.05$.

Results

Table 3 shows the sample characteristics. Of the 60 participants randomized to receive MM, 58 completed the three assessment lab visits, and three had missing data due to technical problems leaving 55 participants with all available data for analysis.

The sample was mainly composed of females (78%) with a mean age of 60.2 (SD ± 7.2). Eighty-nine percent of participants reported being Caucasian (89.1%), with the other 10.9% reporting Hispanic, African American, and Asian heritage. The overall sample was highly educated with a mean of 17 years (SD ± 2.5) of schooling. Considering that the main study from which the adherence data was retrieved targeted the effects of chronic stress among older adults, a minimum score of 9 in the PSS was required. At baseline, the average level of stress was 19 (SD ± 6.1) among participants, denoting a moderated level of stress.

Adherence to Practice and Chosen Types of Meditation

Overall, MM1 and MM2 combined listened to a total of 1916 min of guided practice. From V1 to V2, both cohorts together maintained an average of ~23 min/day (M = 23.25, SD ± 13.29), and for V2 to V3 (8-week follow-up period), participants practiced ~16 min/day (M = 15.98, SD ± 13.10). This decrease in practice time in the whole sample was significantly different [paired t (39) = 9.086, $p \leq 0.001$]. The average percent of days practicing mindfulness for the whole sample was 76% (SD ± 18) between V1 and V2 and 55% (SD ± 31) from V2 to V3.

For this study, we interpreted the most listened meditations as the preferred practices. In order to track participants' preferred practices, we calculated the percentage of time spent listening to each practice considering the total number of minutes recorded with iMINDr. Table 4 shows the percent of time spent in each of the practices from V1 to V3 in both cohorts. The MM1 cohort showed a preference for practicing both body scan and sitting meditation, spending an average of 86% of the time dedicated to the practice of both meditations, with a higher percentage of time spent on body scan (47%). As MM2 had more options for home practice, this cohort evidenced more scattered preferences, but like the other group, sitting meditation (43%) and body scan (29%) were the most popular practices. In both cohorts, the informal practice breathing space (3-step breathing space) was the third most popular type of meditation (MM1 =14%; MM2 =21%). Practices remained in the same rank of choice during the follow-up period, when participants were not being actively instructed to do any practices. Although participants in the MM2 cohort had more options for practice, the practice of sitting meditation, body scan, and breathing space summed more than 90% of their total time practiced. Therefore, we decided to focus only on these practices for the further analyses. To verify if the amounts spent in each practice were different within groups and between cohorts, we compared the percent change between practice time for each of the top three practices in both cohorts. Results of the ANOVA, yielded no significant differences, suggesting both groups to be similar with respect to these practices. Based on that, all further analyses were conducted with the full sample regardless of cohort.

Overall means did not differ for body scan (M = 0.39, SD ± 0.32) and sitting meditation (M = 0.39, SD ± 0.30), p = 0.994. However, means were significantly different for breathing space (M = 0.16, SD = 0.21) and body scan (M = 0.39, SD ± 0.32), p < 0.001, and breathing space and sitting meditation (M = 0.39, SD ± 0.30), p < 0.001. This further clarifies participants' preferences for body scan and sitting meditation practices in particular.

To assess the potential influence of participants' expectancies towards the intervention on levels of adherence, we used expectancy/credibility scale scores as predictors of adherence (average time practiced in %). Linear regressions using scores on both subscales scores (expectancy of stress reduction and the general effect of the intervention) as predictors did not evidence significant effects on the total minutes practiced from V1 to V2 or from V2 to V3 considering the total sample.

Self-Report Measures in Relation to Adherence

Changes in measures' scores across time did not significantly diverge within the two cohorts (MM1 and MM2). Therefore, all analyses comparing scores of measures through time were performed with the total sample. Table 5 shows the variance of scores in each self-report measure across visits. Participants showed significant changes in all measures from V1 to V3 (p < 0.05), indicating a significant effect of mindfulness practice on self-perceptions of stress, mindfulness, and quality of life immediately after MM training and continued improving 8 weeks after the formal training ended (follow-up).

Increased scores on the physical and mental health component of the SF-36, the PSS coping subscale, as well as on the conscientiousness subscale of the NEO-five indicates psychological improvements in dealing with stress and quality of life. We also found significantly decreased scores on depression and stress symptoms as well as reductions in the neuroticism personality trait, reflecting an increased tolerance to negative emotions, which reinforces the overall positive results. Although considerations about the control group are out of the scope of this paper, the full RCT study compared change scores in the self-report measures between intervention and the waitlist control group in both pre- and post-intervention. Results yielded significant differences between groups that were not related to expectancy, suggesting that the changes found in the group that underwent the MM were due to the intervention (specific information can be found at Oken et al. 2017).

Considering the significant differences between waitlist controls and intervention group in the self-reported measures, we performed analyses aiming to verify the influence of the amount and frequency of mindfulness practice with respect to outcomes. Results demonstrated that the relationship between the amount of practice and the self-perception of improvement is not apparent in our data. We used independent ANOVAs to access the influence of the amount of practice time (with tertiles as between factors) and scores changes in self-reports in both post- and follow-up periods (as within factors). The amount of practice did not show a significant effect on score changes in any of the self-reports (see Table 5). A simple linear regression tested the same effect for frequency (% number of days) on outcomes, yielding similar nonsignificant results.

To verify possible effects of different types of mediation on results, we also ran multiple linear regression analyses (forced entry) on total % time practiced for the top three choices (breathing space, body scan, and sitting meditation) as predictors of SF36 [$F(1,53) = 3.669$, $p = 0.060$], PSS [$F(1,53) = 0.890$, $p = 0.350$], CESD [$F(1,53)=$, $p = 0.493$], MAAS [$F(1,53) = p = 0.944$], in % change scores (V2–V1). Results yielded no significant interactions.

As adherence was not related to outcomes, we tested the effect of other variables to verify possible baseline characteristics that may have influenced perceived self-report improvement (in % change scores). For that, we conducted simple linear regressions with sex [$F(1, 53) = 1.233$, $p = 0.272$], age [$F(1, 53) = 0.989$, $p = 0.325$], and baseline scores for conscientiousness [$F(1, 53) = 2.790$, $p = 0.101$], and neuroticism [$F(1, 53) = 0.308$, $p = 0.581$] as predictors of outcomes, but no variables significantly predicted changes.

Discussion

The main goal of this study was to explore adherence to practice as the length, frequency, and type of meditation chosen by novice meditators after an MBI and the relationship between adherence and psychological outcomes. We assessed the mindfulness practice of mildly stressed older adults during a standardized 6-week MM program (Wahbeh et al. 2014) and an 8-week follow-up period through objective electronic measurements.

Consistent with the literature, our sample showed improvements after the MM intervention, presenting increased scores on mindfulness, quality of life and perceived self-efficacy as well as reductions in depression and stress symptoms (Krasner et al. 2009; Lengacher et al. 2009; Nyklicek and Kuijpers 2008; Shapiro et al. 2008). Scores improved through time, being significantly altered in both post-intervention and follow-up visits compared to baseline. Sustained outcome measure improvement after mindfulness interventions has been extensively reported in the literature, even in long-term follow-up periods, reinforcing the benefits of the practice of mindfulness (Grossman 2011; Kabat-Zinn 2005).

Although in our study there was a significant reduction in the time practiced during the follow-up period compared to the formal training period, the average time and frequency spent in practice suggests a good effort from participants to practice mindfulness techniques for at least 3 to 4 days a week after the end of the program. As mentioned previously, a mindful mind is a product of an active and purposeful attentional training that requires frequency and effort (Grossman 2010; Kabat-Zinn 2005). In that sense, participants revealed dedication towards developing the newly acquired mindfulness skills. This is particularly important for our sample, considering that our participants were older adults with moderate levels of stress. This result suggests a good level of adherence to treatment among this population even without the support of a weekly group meeting, which happens in the majority of MBI formats.

The literature reports varying amounts of time for home practice for MBI participants, with studies mentioning practice lengths ranging from 20 to 35 min per day on average (Carmody and Baer 2008; Dobkin and Zhao 2011; Oken et al. 2017; Rosenzweig et al. 2010), which matched our results. However, many of these studies base their home-practice measures on

self-reports that may not be reliable (Wahbeh et al. 2014). In addition, due to the lack of studies based on objective measures of adherence, there are limited data about an optimum dose-response curve addressing the amount of mindfulness practice required for the achievement of the behavioral and physiological benefits. In our study, despite having significant outcomes in several psychological measures, results were not correlated with neither the amount, the type nor the frequency of practice. Our results echoed Dobkin and Zhao (2011) findings on a clinical sample of mixed health conditions that underwent an MBSR program. Their study, however, was based on self-report measures of adherence and did not present a follow-up, having only measured practice during the 8-week intervention to correlate with outcomes. Some authors argue that 6 to 8 weeks of practice might not be enough time to support significant clinical changes in all populations (Dobkin and Zhao 2011), and that the effects on psychological measures in the short-term, which are the most frequently found MBI results, might be due to other reasons than the amount of practice. The practice of mindfulness is not an easy task and requires dedication and tolerance of difficulties such as self-judgment and aversion (Olendzki 2009). Because the practice demands effort and time, it is possible that subjective aspects play a role in the perception of outcomes. One of the most important subjective aspects involved in the outcomes pertains to expectations of improvement, especially after spending considerable time and dedication to the new endeavor (Grossman 2011). In our sample, we measured expectancy towards the intervention for both stress reduction and overall effectiveness of the intervention at baseline. The expectancy levels were high for both stress reduction 3.2(SD ± 0.92) and overall improvements 3.4(SD ± 1.1), suggesting that subjective attitudes towards the study may have had a role in the process. Regression analyses did not evidence significant effects of the levels of expectancy over the total minutes practiced, however, indicating that high expectations were not predicting practice levels among our sample. There was also no relationship between expectancy measures and improvements in the psychological outcomes.

However, it remains possible that the high expectation level of our participants may have had some effect on the improvement in self-rated psychological measures through the placebo effect (Oken 2008). As studies suggest that this is possibly related to personality factors, we also performed analyses to verify the influence of personality traits such as neuroticism and conscientiousness on self-perception of improvements. Results were nonsignificant, indicating that in our study, these traits were not responsible for this effect. Other factors such as sex and age in this sample also did not predict changes in scores.

One possible explanation supporting a placebo effect in this sample, however, relies on the conditioning theory of placebo effects. According to this theory, even psychological interventions can condition participants to perceive improvements after being assigned to intervention arms that resembles situations in which they previously experienced positive effects (Stewart-Williams and Podd 2004). In our study, it is possible that since there was no active control group, we may have possibly induced participants in the MM group to subjectively perceive changes in their life regardless of the amount of mindfulness practice performed. Although sessions were standardized, and mindfulness practices were recorded, it is possible that receiving attention from the facilitator may have contributed to the

triggering of conditioned sensations of well-being in similar situations, leading to the self-perception of improvement following the intervention.

Meditation Type

Beyond the length and frequency of meditation practice, our study explored MBI participants' preferred home meditation practices objectively. Although our sample practiced body scan, sitting meditation, and breathing space most often, our results showed that specific meditation types did not significantly predict changes in any of the psychological measures, or the time and frequency of practices. Despite that, knowledge of participants' meditation practice preferences, especially after the intervention period, is an important piece of information that can help in the process of tailoring interventions to specific populations. Although our participants chose significantly to practice body scan and sitting meditation during and after the training period, they also practiced breathing space quite often (MM1 =14%, MM2 =20%). This result is consistent with previous results reporting informal mindfulness to be among the most frequently chosen practices and one of the most likely to be maintained by participants after MBIs (Barkan et al. 2016; Sibinga et al. 2011). A recent study with a sample of older adults that underwent an MBSR showed 6-month follow-up results on practice adherence, and revealed that participants kept their informal practices for a longer period (4.21 months on average) than the formal practices (2.61 months), which suggests that these practices are more suitable for this population in the long term (Barkan et al. 2016). Our study is consistent with this perspective, reinforcing informal meditation as one of the preferred types of mindfulness practices among older adults.

Our sample was composed of two different cohorts with slightly different meditation practices conducted in class and suggested as take-home. The second cohort (MM2) had the curriculum altered through the insertion of sitting with difficulty, compassion meditation, and the 4-step breathing space resulting in more options for practice. These practices were introduced to facilitate the coping with feelings of self-judgment and self-doubt, which were highly reported by the first cohort (MM1). Despite the second cohort having more options, both cohorts chose to practice both body scan and sitting meditation more consistently, with the informal practice of breathing space as the third option. This result generates a few considerations. One of them is that both sitting meditation and body scan were taught at the beginning of the training for both cohorts and participants were actively encouraged to practice them for longer periods than the other meditations during the program. Another consideration is unique to meditation practice characteristics. Body scan consists of directing the attentional focus on different parts of the body, one-at-a-time (Mehling et al. 2012). This practice is generally one of the first to be taught in MBI programs, and it induces decreases in physiological arousal, stress, and emotional reactivity (Delizonna et al. 2009; Feldman et al. 2010). Sitting meditation, on the other hand, is the most traditional practice and requires a higher level of ability to be alert and focused with an open, aware attitude. Its main goal is to develop full awareness training to shift the attentional focus between the breath and bodily sensations to the surroundings, as well as to emerging emotions and thoughts. Participants of MBIs are usually people with little to no background in meditation practice prior to attending the program, and these two previously mentioned activities seem to be generally easy to understand. Sitting with difficulty and compassion

meditation as well as the 4-step breathing space (an informal practice based on the development of compassionate feelings towards others) require a deeper understanding of the meaning of acceptance and self-compassion. More than an explicit training of attentional skills, these practices encompass concepts such as impermanence, non-self, and the inevitability of suffering in human life (Shonin et al. 2013). As mentioned before, the insertion of the three practices on the MM curriculum was made to help participants reducing high levels of self-judgment. It is possible that the 6-week sessions may not have been enough to explore these concepts in depth with participants, leading them to limit their practice of those other three types of meditation.

Limitations and Future Research Directions

This study presented limitations such as the small sample and the fact that the participants were from two cohorts with different MM curriculums. As the cohorts had different meditation options, our overall analyses of the impact of meditation types and its lengths over the outcomes were limited. Another limitation refers to the specific characteristics of the sample. Our sample consisted of moderately stressed older adults and reflected their choice of practices. It is possible that people in different age ranges would engage in different practices and different doses, changing the overall results. Also, the majority of our sample was composed of highly educated Caucasian women, limiting our results to reflecting mostly the choices and behavior of this population's profile. A more diverse sample might yield different results concerning adherence to mindfulness practice. More studies are needed targeting objective ways to adherence to practice of mindfulness in different populations.

One major limitation is the way adherence was tracked in this study. Although the use of iMINDr provides objective data on mindfulness practice, it is very difficult to assess the quality of mediation. However, is it also possible that factors like quality of meditation, whether in-session or during home practice, would more clearly be associated to actual changes in participants' life experiences. Future studies should address other ways to track adherence and most importantly, the quality of meditation so that more accurate conclusions about the relationship between the amount of practice and outcomes can be drawn following MBIs.

Our results showed the preferred type of meditation for home practices chosen by novice MBI participants, allowing greater knowledge of mindfulness practices participants are more likely to continue with after MBIs. Qualitative studies should address the motivation behind these choices so that specific considerations can be made about the influence of practice type on both adherence and outcomes. Our results also demonstrated that while participants conscientiously practiced at home during and after the MBI training, neither practice time nor the frequency of days practiced was correlated with outcome improvements. These results highlight the need to explore the optimum dose-response for mindfulness practice in regard to desired outcomes as well as the quality of mediation practices and possible placebo effects on the psychological measures.

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References

Baer R (2003). Mindfulness training as a clinical intervention: a conceptual and empirical review. Clinical Psychology-Science and Practice, 10(2), 125–143.

Barkan T, Hoerger M, Gallegos AM, Turiano NA, Duberstein PR, & Moynihan JA (2016). The journal of alternative and complementary medicine, 22(5), 390–395. [PubMed: 27031734]

Bowen S, Chawla N, & Marlatt GA (2010). Mindfulness-based relapse prevention for substance use disorders: a clinician's guide. New York: Guilford Press.

Brown KW, & Ryan RM (2003). The Benefits of Being Present: Mindfulness and Its Role in Psychological Well-Being. Journal of Personality and Social Psychology, 84, 822–848. [PubMed: 12703651]

Carlson LE, & Garland SN (2005). Impact of mindfulness-based stress reduction (MBSR) on sleep, mood, stress and fatigue symptoms in cancer outpatients. International Journal of Behavioral Medicine, 12(4), 278–285. [PubMed: 16262547]

Carmody J, & Baer RA (2008). Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. Journal of Behavioral Medicine, 31, 23–33. doi:10.1002/jclp.20555. [PubMed: 17899351]

Chiesa A, & Serretti A (2011). Mindfulness based cognitive therapy for psychiatric disorders: a systematic review and metaanalysis. Psychiatry Research, 187(3), 441–453. [PubMed: 20846726]

Cohen S, Kamarck T, & Mermelstein R (1983). A global measure of perceived stress. Journal oh Health and Social Behavior, 24(4), 385–396.

Costa PT, & McCrae RR (1992). Professional manual: revised NEO personality inventory (NEO-PI-R) and NEO five-factor inventory (NEO-FFI). Odessa: Psychological Assessment Resources.

Davidson RJ, & Kaszniak AW (2015). Conceptual and methodological issues in research on mindfulness and meditation. American Psychologist, 70(7), 581–592. [PubMed: 26436310]

Delizonna LL, Williams RP, & Langer EJ (2009). The effect of mindfulness on heart rate control. Journal of Adult Development, 16(2), 61–65. doi:10.1007/s10804-009-9050-6.

Devilly GJ, & Borkovec TD (2000). Psychometric properties of the credibility/expectancy questionnaire. Journal of Behavioral Therapy and Experimental Psychiatry, 31, 73–86. doi: 10.1016/S0005-7916(00)00012-4.

Dobkin PL, & Zhao Q (2011). Increased mindfulness-the active component of the mindfulness-based stress reduction program? Complementary Therapies in Clinical Practice, 17(1), 22–27. [PubMed: 21168110]

Elwafi HM, Witkiewitz K, Mallik S, Thornhill TA, & Brewer J (2013). Mindfulness training for smoking cessation: moderation of the relationship between craving and cigarette use. Drug and Alcohol Dependence, 130, 222–229. [PubMed: 23265088]

Feldman G, Greeson J, & Senville J (2010). Differential effects of mindful breathing, progressive muscle relaxation, and loving-kindness meditation on decentering and negative reactions to repetitive thoughts. Behaviour Research and Therapy, 48(10), 1002–1011. doi:10.1016/j.brat. 2010.06.006. [PubMed: 20633873]

Fjorback LO, Arendt M, Ornbol E, Fink P, & Walach H (2011). Mindfulness-based stress reduction and mindfulness-based cognitive therapy: a systematic review of randomized controlled trials. Acta Psychiatrica Scandinavica, 124(2), 102–119. [PubMed: 21534932]

Giluk TL (2009). Mindfulness, Big Five personality, and affect: a meta-analysis. Personality and Individual Differences, 47, 805–811.

Grossman P (2010). Mindfulness for psychologists: paying kind attention to the perceptible. Mindfulness, 1, 87–97. doi:10.1007/s12671-0100012-7.

Grossman P (2011). Defining mindfulness by how poorly I think I pay attention during everyday awareness and other intractable problems for psychology's (re)invention of mindfulness: comment on Brown et al. (2011). Psychological Assessment, 23(4), 1034–1040. [PubMed: 22122674]

Hofmann SG, Sawyer AT, Witt AA, & Oh D (2010). The effect of mindfulness based therapy on anxiety and depression: a meta-analytic review. Journal of Consulting and Clinical Psychology, 78(2), 169–183. [PubMed: 20350028]

Kabat-Zinn J (2005). Wherever you go, there you are: mindfulness meditation. New York: Hyperion.

Keune PM, & Forintos DP (2010). Mindfulness meditation: a preliminary study on meditation practice during everyday life activities and its association with well-being. Psychological Topics, 19(2), 373–386.

Khoury B, Lecomte T, Fortin G, Masse M, Therien P, Bouchard V, & Hofmann SG (2013). Mindfulness based therapy: a comprehensive meta-analysis. Clinical Psychology Review, 33, 763–771. [PubMed: 23796855]

Knopman DS, Roberts RO, Geda YE, Pankratz VS, Christianson TJ, Petersen RC, & Rocca WA (2010). Validation of the telephone interview for cognitive status modified in subjects with normal cognition, mild cognitive impairment, or dementia. Neuroepidemiology, 34(1), 34–42. doi: 10.1159/000255464. [PubMed: 19893327]

Krasner MS, Epstein RM, Beckman H, Suchman AL, Chapman B, Mooney CJ, & Quill TE (2009). Association of an educational program in mindful communication with burnout, empathy, and attitudes among primary care physicians. JAMA, 302, 1284–1293. [PubMed: 19773563]

Lee EH (2012). Review of the psychometric evidence of the perceived stress scale. Asian Nursing Research (Korean Soc Nurs Sci)., 6(4), 121–127. doi:10.1016/j.anr.2012.08.004.

Lengacher CA, Johnson-Mallard V, Post-White J, Moscoso MS,Jacobsen PB, Klein TW, Kip KE (2009). Randomized controlled trial of mindfulness-based stress reduction (MBSR) for survivors of breast cancer. Psychooncology, 18, 1261–72. [PubMed: 19235193]

McHorney CA, Ware JE, & Raczek AE (1993). The MOS 36-item short-form health survey (SF-36): II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. Medical Care, 31(3), 247–263. [PubMed: 8450681]

Mehling WE, Price C, Daubenmier JJ, Acree M, Bartmess E, & Stewart A (2012). The multidimensional assessment of interoceptive awareness (MAIA). PLoS ONE, 7(11). 10.1371/journal.pone.0048230.

Miller JJ, Fletcher K, & Kabat-Zinn J (1995). Three-year follow-up and clinical implications of a mindfulness meditation-based stress reduction intervention in the treatment of anxiety disorders. General Hospital Psychiatry, 17, 192–200. [PubMed: 7649463]

Morgan LPK, Graham JR, Hayes-Skelton SA, Orsillo SM, & Roemer L (2014). Relationships between amount of post-intervention mindfulness practice and follow-up outcome variables in an acceptance-based behavior therapy for Generalized Anxiety Disorder: the importance of informal practice. Journal of Contextual Behavioral Science, 3, 173–178. [PubMed: 25328862]

Nyklicek I, & Kuijpers KF (2008). Effects of mindfulness-based stress reduction intervention on psychological well-being and quality of life: is increased mindfulness indeed the mechanism? Annals of Behavioral Medicine, 35, 331–340. [PubMed: 18535870]

Oken BS (2008). Placebo effects: clinical aspects and neurobiology.Brain, 131, 2812–2823. [PubMed: 18567924]

Oken BS, Chamine I, & Wakeland W (2015). A systems approach to stress, stressors and resilience in humans. Behavioral Brain Research, 282, 144–154.

Oken BS, Wahbeh H, Goodrich E, Klee D, Mormont T, Miller M, & Fu R (2017). Meditation in stressed older adults: improvements in self-rated mental health not paralleled by improvements in

cognitive function or physiological measures. Mindfulness, 8(3), 627–638. doi:10.1007/s12671-016-0640-7. [PubMed: 28603562]

Olendzki A (2009). Mindfulness and meditation In Didonna F (Ed.), Clinical handbook of mindfulness (pp. 37–44). New York: Springer.

Ong JC, Shapiro SL, & Manber R (2009). Mindfulness meditation and cognitive behavioral therapy for insomnia: a naturalistic 12-month follow-up. Explore, 5, 30–36. [PubMed: 19114261]

Pocock SJ, & Simon R (1975). Sequential treatment assignment with balancing for prognostic factors in the controlled clinical trial. Biometrics, 31, 103–115. doi:10.2307/2529712. [PubMed: 1100130]

Pradhan EK, Baumgarten M, Langenberg P, Handwerger B, Gilpin AK, Magyari T, & Berman BM (2007). Effect of mindfulness-based stress reduction in rheumatoid arthritis patients. Arthritis & Rheumatology, 57, 1134–42.

Radloff L (1977). The CES-D scale: a self-report depression scale for research in the general population. Applied Psychological Measurement, 1, 385–401.

Rosenzweig S, Greeson JM, Reibel DK, Green JS, Jasser SA, & Beasley E (2010). Mindfulness-based stress reduction for chronic pain conditions: variation in treatment outcomes and role of home meditation practice. Journal of Psychosomatic Research, 68, 29–36. [PubMed: 20004298]

Segal ZV, Bieling P, Young T, MacQueen G, Cooke R, Martin L, & Levitan RD (2010). Antidepressant monotherapy vs. sequential pharmacotherapy and mindfulness-based cognitive therapy, or placebo, for relapse prophylaxis in recurrent depression. Archives in General Psychiatry, 67(12), 1256–1264.

Sephton SE, Salmon P, Weissbecker I, Ulmer C, Floyd A, Hoover K, & Studts JL (2007). Mindfulness meditation alleviates depressive symptoms in women with fibromyalgia: results of a randomized clinical trial. Arthritis & Rheumatology, 57, 77–85.

Shapiro SL, Bootzin RR, Figueredo AJ, Lopez AM, & Schwartz GE (2003). The efficacy of mindfulness-based stress reduction in the treatment of sleep disturbance in women with breast cancer: an exploratory study. Journal of Psychosomatic Research, 54, 85–91. [PubMed: 12505559]

Shapiro SL, Oman D, Thoresen CE, Plante TG, & Flinders T (2008). Cultivating mindfulness: effects on well-being. Journal of Clinical Psychology, 64, 840–862. [PubMed: 18484600]

Shonin E, Van Gordon W, & Griffiths MD (2013). Mindfulness-based interventions towards mindful clinical integration. Frontiers in Psychology, 4(194), 1–4. doi:10.3389/fpsyg.2013.00194. [PubMed: 23382719]

Sibinga EM, Kerrigan D, Stewart M, Johnson K, Magyari T, & Ellen JM (2011). Mindfulness-based stress reduction for urban youth. Journal of Alternative and Complementary Medicine, 17(3), 213–218. [PubMed: 21348798]

Stewart-Williams S, & Podd J (2004). The placebo effect: dissolving the expectancy versus conditioning debate. Psychological Bulletin, 130(2), 324–340. [PubMed: 14979775]

Tang YY, Holzel BK, & Posner MI (2015). The neuroscience of mindfulness meditation. Nature Reviews Neuroscience, 16(4), 213–225. [PubMed: 25783612]

Wahbeh H, Zwickey H, & Oken B (2011). One method for objective adherence measurement in mind-body medicine. The Journal of Alternative and Complementary Medicine, 17, 1–3. doi:10.1089/acm.2010.0316. [PubMed: 21265648]

Wahbeh H, Lane JB, Goodrich E, Miller M, & Oken BS (2014). One-on-one mindfulness meditation trainings in a research setting. Mindfulness, 5, 88–99. doi:10.1007/s12671012-0155-9. [PubMed: 24554970]

Table 1

Outline of weekly in-lab and home-practice guided meditations

Week	In-lab guided meditations		Daily home-practice guided meditations	
	1st cohort (MM1)	2nd cohort (MM2)	MM1	MM2
1	-Raisin exercise -Body scan	Same as MM1	-Introduction -Body scan	Same as MM1
2	-Body scan -Introduction to sitting meditation	Same as MM1	-Body scan -Sitting meditation	Same as MM1
3	-Sitting meditation -Intro to 3-step breathing space	Same as MM1	-Sitting meditation -Three 3-step breathing space	Same as MM1
4	-Sitting with difficulty meditation -Introduction to 3-step coping space	Same as MM1	-Sitting meditation -Three 3-step breathing space	-Sitting with difficulty meditation -Three 3-step breathing space
5	-Sitting with difficulty meditation	-Compassion meditation -Introduction to 4-step breathing space -Introduction to 4-step coping space	-Sitting meditation and/or body scan -Three 3-step breathing space	-Compassion meditation -Three 4-step breathing space
6	-Body scan	Same as MM1	-Sitting meditation and/or body scan -Three 3-step breathing space	-Body scan, sitting meditation, sitting with difficulty meditation, and/or compassion meditation -Three 4-step breathing space

The curriculum of in-lab and home practices was slightly changed halfway through the study resulting in two cohorts. Participants enrolled in the first part of the study are identified as MM1 (1st cohort) and the ones who received the altered curriculum are the MM2 (2nd cohort)

Table 2

Length of audio guided meditations in cohort 1 and cohort 2

1st cohort (MM1)	2nd cohort (MM2)
1. Introduction (6:13)	1. Introduction (6:13)
2. Body scan (29:45)	2. Body scan (29:45)
3. Sitting meditation (26:00)	3. Sitting meditation (26:00)
4. 3-step breathing space (4:11)	4. step breathing space (4:11) 5. Sitting w/ difficulty Mdt (30:30) 6. Compassion meditation (30:00) 7. 4-step breathing space (4:00)

Table 3

Participant demographics

Number of female participants	78
Age (mean)	60.2 ±7.4
Years of education (mean)	17.0 ±2.5
Underrepresented groups (number)	
Hispanic	3
African American	1
Asian	2
Perceived stress scale at visit 1 (mean)	19.0 ±6.1

Table 4

Percentage of total meditation practice time on each type of meditation among participants

MM1 (*N* =37)		**MM2 (*N*= 18)**	
Meditation type	Mean percent time spent on each practice (%)	Meditation type	Mean percent time on each practice (%)
Body scan	47 (SD ± 0.32)	Body scan	29 (SD ± 26)
Sitting meditation	39 (SD ± 0.32)	Sitting meditation	43 (SD ± 27)
3-step breathing space	14 (SD ±0.20)	3-step breathing space	21 (SD ± 24)
		Sitting w/ difficulty Mdt	1 (SD ± 4)
		Compassion meditation	3 (SD ± 10)
		4-step breathing space	3 (SD ± 10)

Values express the percent time listened by each participant averaged within the group and rounded to the nearest tenth

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Table 5

Changes in measures scores through time and their relationship with adherence

Measures	*N*	Visit 1		Visit 2		Visit 3		Repeated measures ANOVA lab visits		Repeated measures ANOVAvisits/adherence**			
		Mean	SD	Mean	SD	Mean	SD	*F*	*df*	V1-V2		V2-V3	
										F	*df*	*F*	*df*
Expectancy for stress reduction	55	3.2	0.92	-	-	-	-	-		-		-	
Expectancy for effect of the intervention	55	3.4	1.1	-	-	-	-	-		-		-	
CESD	55	17.2	8.5	12*	6.3	11.5*	7.7	22.926*	2	0.485	2	0.701	2
MAAS	55	3.4	0.7	3.7*	0.65	4*	0.72	25.421*	2	1.201	2	0.300	2
NEO_neuroticism	55	24	7.2	20*	7.6	19*	7.4	29.010*	2	0.424	2	0.303	2
NEO_conscientiousness	55	28	7.6	31*	6.4	31*	6.9	13.214*	2				
PSS total	55	18	6.02	15*	5.4	13*	6.6	20.589*	2	0.353	2	0.524	2
PSS distress	55	14	4.8	11*	4.1	9.9*	5.1	16.672*	2	0.454	2	0.583	2
PSS coping	55	5.2	1.2	5.5*	1.1	6.0*	1.3	10.139*	2	2.259	2	0.884	2
SF-36	55	37	9.5	44*	9.4	46*	8.7	29.526*	2	0.861	2	0.384	2

Greenhouse-Geiser test

* $p \leq 0.05$, significance when compared to V1,

** adherence (% minutes) grouped in tertiles