

Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program

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Abstract Relationships were investigated between home practice of mindfulness meditation exercises and levels of mindfulness, medical and psychological symptoms, perceived stress, and psychological well-being in a sample of 174 adults in a clinical Mindfulness-Based Stress Reduction (MBSR) program. This is an 8-session group program for individuals dealing with stress-related problems, illness, anxiety, and chronic pain. Participants completed measures of mindfulness, perceived stress, symptoms, and well-being at pre- and post-MBSR, and monitored their home practice time throughout the intervention. Results showed increases in mindfulness and well-being, and decreases in stress and symptoms, from pre- to post-MBSR. Time spent engaging in home practice of formal meditation exercises (body scan, yoga, sitting meditation) was significantly related to extent of improvement in most facets of mindfulness and several measures of symptoms and well-being. Increases in mindfulness were found to mediate the relationships between formal mindfulness practice and improvements in psychological functioning, suggesting that the practice of mindfulness meditation leads to increases in mindfulness, which in turn leads to symptom reduction and improved well-being.

Keywords Mindfulness · Mindfulness based stress reduction · Meditation · Medical symptoms · Psychological symptoms · Wellbeing · Stress

An increasing body of research supports physical and mental health benefits of participation in mindfulness training. Recent reviews of the empirical literature (Baer 2003; Grossman et al. 2004; Salmon et al. 2004; Hayes et al. 2006) suggest that several interventions that incorporate mindfulness, including mindfulness-based stress reduction (MBSR) (Kabat-Zinn 1982; Kabat-Zinn 1990), mindfulness-based cognitive therapy (MBCT) (Segal et al. 2002), dialectical behavior therapy (DBT) (Linehan 1993) and acceptance and commitment therapy (ACT) (Hayes et al. 1999); lead to clinically significant improvements in psychological functioning in a wide range of populations. As evidence for the efficacy of these interventions continues to grow, the importance of investigating the mechanisms of action by which mindfulness training exerts salutogenic effects is increasingly recognized (Dimidjian and Linehan 2003; Baer et al. 2006; Hayes et al. 2006; Shapiro et al. 2006). Examination of this question requires methods to assess levels of mindfulness to determine whether individuals engaged in the practice of mindfulness are in fact becoming more mindful over time, and if so, whether these increases are responsible for the positive outcomes observed.

The recent literature includes several newly developed self-report measures of a general tendency to be mindful in daily life (Baer et al. 2004; (Buchheld et al. 2001; Brown and Ryan 2003; Feldman et al. In press). These measures have been shown to be significantly correlated with each other and to have promising psychometric properties (Baer et al. 2006). However, differences in their content and

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structure suggest some disagreement between researchers about how mindfulness should be defined and operationalized. In particular, the number of components or facets of mindfulness varies widely across instruments. In a recent study of facets of mindfulness, Baer et al. (2006) conducted exploratory factor analysis of the combined item pool from all available mindfulness questionnaires and found that a five-factor structure appeared to capture several distinct but related underlying dimensions. Items with the highest loadings on each of the five factors (and low loadings on all other factors) were combined to form the Five Facet Mindfulness Questionnaire (FFMQ) (Baer et al. 2006), which assesses five elements of mindfulness. These include *observing* (attending to or noticing internal and external stimuli, such as sensations, emotions, cognitions, sights, sounds, and smells), *describing* (noting or mentally labeling these stimuli with words), *acting with awareness* (attending to one's current actions, as opposed to behaving automatically or absent-mindedly), *non-judging of inner experience* (refraining from evaluation of one's sensations, cognitions, and emotions) and *non-reactivity to inner experience* (allowing thoughts and feelings to come and go, without attention getting caught up in them). Examples of items for each factor can be seen in Table 1.

These five facets of mindfulness have shown good internal consistency and correlations in the expected directions with many variables predicted to be related to mindfulness, such as experiential avoidance, thought suppression, openness to experience, and emotional intelligence (Baer et al. 2006). Significant relationships with meditation experience in long-term meditation practitioners also have been documented (Baer et al. 2007), but changes in these facets of mindfulness over the course of a mindfulness-based program in a clinical setting have not been investigated. One purpose of the current study therefore, was to examine whether participation in MBSR is associated with changes in levels of mindfulness, as measured by the FFMQ.

The foundation and methodology of MBSR has been described in detail elsewhere (Kabat-Zinn 1982; Kabat-Zinn 1990). Briefly, it is a group program that focuses on the cultivation of mindfulness through instruction in formal

meditation practices (sitting meditation, body scan, mindful yoga), and the integration of this capacity into everyday life as a coping resource for dealing with intensive physical symptoms and difficult emotions (Kabat-Zinn 1994). Participants attend eight weekly 2 1/2 h sessions, plus an all-day session on a weekend day during the sixth week. These sessions include training in formal mindfulness practices as well as group interaction. Class discussion centers around the challenges and achievements participants are experiencing using mindfulness in the face of stressful situations occurring in their everyday lives. In the body scan, participants focus attention sequentially on parts of the body, non-judgmentally noticing whatever sensations may be present in each area. Mindful hatha yoga postures also are practiced to develop awareness during gentle movements and stretching. In sitting meditation, participants use awareness of the sensations of breathing as a baseline attentional focus, while noticing any other sensations in the body, sounds in the environment, and/or cognitions and feeling states that also present themselves to attention. In addition, participants are encouraged to engage in informal mindfulness practice by doing everyday activities (such as eating, walking, washing the dishes, etc) with full awareness of the associated movements, sensations, cognitions and feelings that may be present. Participants are given two CD's containing instructions to guide their formal meditation practices (body scan, yoga, and sitting meditation) and encouraged to practice at home by listening to the CD for 45 min each day throughout the seven weeks of the program (Kabat-Zinn 1990).

The importance of regular out-of-class practice in establishing the capacity for mindfulness in everyday life, and hence its purported benefits, is also clearly stated in other mindfulness-based programs. The manual for MBCT recommends 45 min of daily practice in order to obtain the benefits of participation (Segal et al. 2002) and a recent ACT manual (Hayes and Smith 2005) suggests practicing for 15–30 min per day. In DBT, the importance of regular practice is emphasized, but specific practice goals are determined by clients and their therapists. While this expectation of daily practice is well established in the Buddhist meditation traditions upon which these programs

Table 1 Example items for mindfulness facets

Facet	Example item
Observing	I notice the smells and aromas of things.
Nonreactivity to inner experience	I perceive my feelings and emotions without having to react to them.
Describing	I'm good at finding words to describe my feelings.
Nonjudging of inner experience	I think some of my emotions are bad or inappropriate and I shouldn't feel them. (R)
Acting with awareness	I find myself doing things without paying attention. (R)

Note: R = reverse-scored item (higher scores represent higher levels of mindfulness)

draw, there is limited empirical evidence for the effects of home practice in clinical populations.

In a sample of women with binge eating disorder who completed a 6 week mindfulness-based treatment, Kristeller and Hallett (1999) found that time spent in the practice of eating-related mindfulness exercises was significantly correlated with degree of improvement in binge eating. Practice of “mini-meditations,” in which participants stop for a few moments at key times during daily activities to practice nonjudgmental awareness of thoughts and feelings, was significantly related to improvements in depressive symptoms. In a subsequent study with a similar population, time spent engaging in eating-related mindfulness exercises was significantly related to improvements in eating control (Kristeller et al. under review). In a study of MBSR with cancer outpatients, Specia et al. (2000) reported that home practice of meditation was significantly related to improvements in mood. In contrast, Astin (1997) found that practice time and symptom improvement were not significantly correlated in a sample of college students completing MBSR. Similarly, Davidson (2003) found no relationship between reported practice time during an MBSR course and degree of change in either biological or self-report measures in a worksite sample of healthy employees. Since most participants in mindfulness-based programs are likely to have many competing time demands, the disclosure of the expectation of lengthy out-of-class practice may act as a barrier to participation for some. For these reasons, and also to further understanding of mechanisms of action, it is important to clarify and confirm the role of home practice in obtaining the program’s potential benefits.

In light of the above, the purpose of the present study was to investigate three related questions: (1) Whether participation in MBSR was associated with increases in mindfulness as measured by the FFMQ; (2) if such increases were observed, whether the amount of out-of-class practice of mindfulness was related to improvement in mindfulness scores; and (3) if support for this relationship was found, whether the increases in levels of mindfulness mediate the relationship between mindfulness practice and any observed improvements in psychological functioning and reported medical symptoms. Our outcome variables included measures of medical and psychological symptoms shown in previous research to be associated with significant improvements in MBSR participants (see section on measures below). In addition, because meditation traditions consistently suggest that the practice of mindfulness cultivates positive qualities such as wisdom, compassion, insight, and equanimity (Shapiro et al. 2002), we included a measure of psychological well-being (Ryff 1989) that assesses aspects of psychological health independent of symptom levels. This measure has not been included in previous studies of MBSR.

Methods

Participants

Study participants were drawn from individuals enrolled in the University of Massachusetts Medical School MBSR program in Worcester MA during 2006. While detailed data were not available on participants’ diagnoses, the MBSR groups included adults with a wide range of problems including illness-related stress, chronic pain, anxiety, and personal and employment-related stress. Each class included approximately 20–25 participants; about half were referred by their health-care practitioner and others were self-referred. Participation in the program is on a self-pay basis. Self-report data for program evaluation and participant information are routinely collected before the first class, and again at the end of each 8-week group. All participants are asked on the intake questionnaire whether their response information can be used for research purposes, on condition that they are not identified as individuals. The current study includes data from the 96% of the participants who consented to the use of their data for research purposes.

A total of 206 individuals in nine MBSR groups who consented to the use of their data completed the pre-intervention measures. Of these, 10 (5%) attended three or fewer sessions and provided no assessment data at post-intervention. Of the remaining 196, 22 attended four or more sessions but failed to provide post-intervention assessment data. Thus, data at both pre- and post-MBSR were available for 174 participants (85% of those who consented to participate). Of these, 168 (97%) attended six or more of the eight weekly sessions, whereas five participants attended five sessions or fewer. Attendance data for one participant were unavailable. The all-day session in week six was attended by 150 (86%) of these participants.

The mean age of the 174 participants was 47.05 years (SD = 10.26, range 19–68) and 63% were female. Most were married (65%) or cohabitating (9%), whereas 12% were single, 9% were separated, divorced, or widowed, and 5% did not answer this question. Most participants reported white collar and professional occupations. Current or previous participation in psychotherapy was reported by 63% of the sample.

Differences between the participants who failed to provide post-treatment data (N = 32) and the rest of the sample (N = 174) were examined using one-way analysis of variance and chi-square analyses. No significant differences were found for demographic variables (age, gender, marital status, participation in psychotherapy) or for any of the dependent variables as measured at pre-treatment (medical and psychological symptoms, perceived stress,

well-being, mindfulness). Thus, the 174 participants included in analyses described later appear to be representative of the slightly larger group that consented to participate.

Procedures

Prospective MBSR participants attend an orientation/information session during the three weeks prior to the beginning of each 8-week group. In these sessions the goals and format of the program are explained and any questions they may have about their participation are answered. Pre-program questionnaires (described below) were completed immediately prior to these orientation sessions. Post-program instruments were completed during the final MBSR session. Home practice data were derived from a mindfulness practice log in which participants recorded the number of minutes of formal and informal mindfulness practice they did each day. Participants placed their completed logs in the slot of a closed purpose-built box that was in the classroom each week. The study assistant collected the logs from the box following each session. Respondents were assured that their responses would not be seen by the instructor. Logs were color-coded by week. Participants who forgot to bring their log to class were asked to fill out a retrospective plain white log for that week.

Measures

Demographic characteristics were assessed at pre-intervention only. Participants reported their age, gender, marital status, occupation, any history of substance abuse, and past or current participation in psychotherapy.

Variables assessed at both pre- and post-MBSR included mindfulness, medical and psychological symptoms, perceived stress, and psychological well-being. Home mindfulness practice was assessed throughout the intervention.

Mindfulness was assessed using the FFMQ (Baer et al. 2006). This instrument was derived from a factor analysis of questionnaires measuring a trait-like general tendency to be mindful in daily life. It consists of 39 items assessing five facets of mindfulness: *observing*, *describing*, *acting with awareness*, *non-judging of inner experience*, and *non-reactivity to inner experience*. Items are rated on a Likert scale ranging from 1 (never or very rarely true) to 5 (very often or always true). The FFMQ has been shown to have good internal consistency and significant relationships in the predicted directions with a variety of constructs related to mindfulness (Baer et al. 2006).

Home mindfulness practice was assessed using a folder of seven color-coded homework logs—one color for each

of the seven weeks of the MBSR program. Participants were asked to record the number of minutes of home practice they did each day in each of the formal meditation practices taught in the program (body scan, mindful yoga, sitting meditation) as well as the minutes of informal (becoming mindful in everyday activities) practice.

Psychological symptoms were assessed with the Brief Symptom Inventory (BSI) (Derogatis 1992) which includes 53 items and provides nine sub-scale scores measuring a range of psychological symptoms and somatic complaints. A global severity index (GSI) also can be calculated. Studies of MBSR show significant reductions in GSI, anxiety and depression associated with participation in the program (Shapiro et al. 1998; Williams et al. 2001; Majumdar et al. 2002).

Medical symptoms were assessed using the Medical Symptom Checklist (MSCL) (Kabat-Zinn 1982). This is a list of 115 common medical symptoms and respondents are asked to check those they have experienced as bothersome in the past month. The score is the total number of symptoms checked. While the reliability and validity of the MSCL have not been evaluated, several studies of MBSR have shown significant reductions in the MSCL associated with participation in the program (Kabat-Zinn et al. 1985; Kabat-Zinn 1987; Kabat-Zinn and Chapman-Waldrop 1988; Kabat-Zinn et al. 1992; Williams et al. 2001).

Perceived stress was assessed using the Perceived Stress Scale (PSS) (Cohen et al. 1983; Cohen and Williamson 1988), a widely-used and well-validated 10-item scale that measures the degree to which situations in one's life over the past month are appraised as unpredictable, uncontrollable and overwhelming. It posits that people appraise potentially threatening or challenging events in relation to their available coping resources. A higher score indicates a greater degree of perceived stress. Participation in MBSR has been associated with significant declines in PSS scores (Carmody et al. 2006).

Psychological Well-Being was assessed using the Scales of Psychological Well-Being (Ryff and Keyes 1995) which conceptualize psychological well-being (PWB) as having six elements: self-acceptance (positive attitude toward one's self, life, and past, including good and bad qualities), positive relations with others (warm, satisfying, trusting relationships), autonomy (independence, ability to resist social pressures and follow own standards), environmental mastery (competence in managing life's demands), purpose in life (goals and direction, sense of meaning), and personal growth (view of self as growing and developing, openness to new experiences). The PWB scales measure these six elements and are available in several lengths. The 54-item version, with nine items per

scale, was used in the present study. This version has been shown to have good psychometric properties (Sewell et al. 2004). We used a total score derived by summing the elements of well-being.

Results

Changes in mindfulness facets, well-being, perceived stress and symptoms

Changes in all variables from pre- to post-MBSR ($N = 174$) can be seen in Table 2. Paired sample t -tests showed that all variables changed significantly and in the expected direction. Pre-post effect sizes (Cohen's d) were calculated using the formula suggested by Rosenthal (1984) for matched-pairs data ($d = t/\sqrt{df}$). Scores on all mindfulness facets increased significantly pre- to post-program. Effect sizes were large for *observing* and *non-reactivity to inner experience* and moderate for *describing*, *acting with awareness*, and *non-judging*. Psychological well-being subscales also increased significantly in association with program participation, and showed a large

effect size. Medical and psychological symptoms and perceived stress levels all decreased significantly, with moderate to large effect sizes.

Home mindfulness practice

Of the 174 participants who provided both pre- and post-MBSR assessment data, 121 (69.5%) provided some or all of their home practice data. Only these 121 participants are included in the following analyses of practice time. For these 121 participants, the mean number of practice logs provided was 6.16 out of a possible seven ($SD = 1.34$), and 91% provided five or more of the seven logs. For missing logs, values of zero were entered. Thus, practice times may be under-estimates, as participants may have engaged in mindfulness practice on days for which they completed no logs.

For each of the formal practices, a mean of 97.7% of reported practice times fell between 0 and 45 min. Nearly all of the remaining practice times fell between 46 and 90 min. A few individuals occasionally reported practicing one particular exercise on one specific day for 100–300 min. These latter reports, although extreme,

Table 2 Means and SD's, paired sample t -tests, and pre-post effect sizes for all variables

Variable	Pre-MBSR		Post-MBSR		t	d
	M	SD	M	SD		
Mindfulness facets						
Observe	23.79	5.84	28.28	4.72	−11.94**	.91
Describe	26.90	6.42	28.92	6.02	−6.12**	.47
Act with awareness	23.72	5.76	26.49	5.13	−7.60**	.58
Nonjudge	26.34	7.01	30.78	5.86	−8.70**	.68
Nonreact	17.97	4.98	22.19	4.13	−11.09**	.86
Psychological well-being	227.62	37.41	246.55	37.95	−9.77**	.77
Perceived stress	22.13	6.19	15.78	6.33	13.14**	1.02
Symptom measures						
MSCL	21.63	12.09	13.66	9.77	11.83**	.90
BSI-global severity	0.77	0.47	0.53	0.40	8.38**	.65
Somatization	0.55	0.57	0.42	0.48	3.54*	.27
Obsessive-compulsive	1.34	0.82	0.96	0.68	7.61**	.58
Interpersonal sensitivity	0.92	0.85	0.62	0.64	5.86**	.45
Depression	0.81	0.70	0.57	0.65	5.64**	.44
Anxiety	1.04	0.74	0.65	0.53	7.84**	.61
Hostility	0.75	0.65	0.46	0.46	6.84**	.53
Phobic anxiety	0.32	0.51	0.17	0.38	3.83**	.30
Paranoia	0.55	0.61	0.41	0.46	4.15**	.32
Psychoticism	0.54	0.54	0.37	0.45	4.99**	.39

Note. MSCL = Medical Symptom Checklist, BSI = Brief Symptom Inventory

* $p < .01$, ** $p < .001$

represented less than .05% of all reported practice times. To normalize the distribution of practice times and reduce the potential influence of outliers on the analyses that follow, reported daily practice times for each exercise were coded on a 0–10 scale, in which 0 = no practice, 1 = 1–5 min of practice, 2 = 6–10 min, 3 = 11–15 min, and so on, with 10 = greater than 45 min of practice.

Participants were encouraged to engage in out-of-class practice 6 days per week and homework practice logs were requested at sessions two through eight (seven weeks) yielding a maximum total number of 42 expected practice days. While the sequence of introduction of the formal mindfulness techniques could vary in individual classes at the discretion of the instructor, generally during the first two weeks participants were asked to practice the body scan 6 days per week. Mindful yoga was introduced in the third session and participants were asked to practice the body scan and yoga on alternate days during the following two weeks. While short sitting meditation periods were introduced during the first four sessions and participants were encouraged to practice this at home, the 45-min recording of guided sitting meditation was not introduced until the fifth session. At that time, participants were instructed to practice the sitting meditation on alternate days, with their choice of either the body scan or the yoga on the intervening days. After that, they were given considerable flexibility to choose which exercise(s) to practice each day.

Table 3 shows the mean number of days on which participants reported practicing each exercise, together with the mean duration (in min) of practice on each of those days, and the total number of hours of practice over the course of the program. On the average, participants reported practicing the body scan on 19.6 days, for 31–35 min each day that they practiced it. Participants practiced yoga on nearly 17 days, for 16–20 min per day. Sitting meditation was reported on roughly 20 days, for 16–20 min per day. Many participants reported engaging in more than one formal practice on a single day. The average number of days on which any formal practice occurred (body scan, sitting, and/or yoga) was 33.55, or 80% of the 42 assigned days of practice. The average total practice time for all formal practices combined was 31–35 min per

day. Informal practice (becoming mindful in everyday activities) was reported on a mean of just under 20 days, for an average of 11–15 min per day.

Relationships between home mindfulness practice and other variables

We examined whether time reported spent in mindfulness practice was related to the extent of change in mindfulness, well-being, and medical and psychological symptoms. For these analyses, daily homework practice times (coded on the 0–10 scale described above) for each exercise were summed, yielding a total reported practice time for each exercise over the course of the 7-week program.

Table 4 shows correlations between total practice time and pre-post changes in all dependent variables. Because of the large number of correlations presented, only those with p values less than .01 are considered significant. These findings suggest that practice time for formal meditation (body scan, yoga, sitting) is associated with many changes in the beneficial direction. Practice of the body scan was significantly related to increases in the mindfulness facets of *observing* and *non-reactivity to inner experience*, increases in psychological well-being, and decreases in interpersonal sensitivity and anxiety. Yoga practice was significantly associated with changes in four of five mindfulness facets (all but *describing*), well-being, perceived stress levels, and several types of psychological symptoms. A similar pattern was seen for total formal practice time (body scan, sitting, and yoga combined). Practice of sitting meditation was significantly associated with changes in two mindfulness facets (*acting with awareness* and *non-reactivity*), psychological well-being, and symptoms of psychoticism (social alienation and concerns about the health of one's mind). In contrast, reported informal mindfulness practice (doing routine activities mindfully) showed no significant relationships with changes in any of the dependent variables. In addition, changes in the *describing* facet of mindfulness were not related to practice times for any of the mindfulness exercises. No significant correlations were found between practice time and change in medical symptoms.

Table 3 Homework practice during MBSR course for 121 participants providing homework data

Mindfulness exercise	Total days practiced		Minutes per day practiced			Total hours practiced
	Mean	SD	Mean	Minimum	Maximum	
Body scan	19.61	9.32	31–35	6–10	>45	10.79
Movement (yoga)	16.92	11.14	16–20	1–5	41–45	5.08
Sitting meditation	19.70	10.98	16–20	1–5	41–45	5.91
Any formal practice	33.55	10.87	31–35	6–10	>45	18.45
Informal practice	19.94	13.69	11–15	1–5	>45	4.3

Table 4 Correlations between total practice time during MBSR course and pre-post changes in other variables for 121 participants providing homework data

	Body scan	Movement (yoga)	Sitting meditation	Total formal practice	Informal practice
Mindfulness facets					
Observe	.29*	.24*	.23	.33*	.21
Describe	.02	.02	.04	.03	.02
Act with awareness	.09	.32*	.26*	.27*	.14
Nonjudge	.08	.26*	.09	.18	.03
Nonreact	.28*	.32*	.26*	.36*	.09
Psychological well-being	.27*	.42*	.32*	.42*	.21
Medical symptoms	.17	.19	.12	.21	.03
Perceived stress	.16	.24*	.23	.26*	.15
Psychological symptoms					
Somatization	.14	.14	.12	.17	-.02
Obsessive-compulsive	.10	.13	.03	.12	.06
Interpersonal sensitivity	.24*	.31*	.19	.31*	.08
Depression	.05	.18	.15	.15	.01
Anxiety	.26*	.25*	.19	.29*	.09
Hostility	.04	.06	-.02	.04	-.12
Phobic anxiety	.15	.33*	.16	.26*	.21
Paranoia	.06	.17	.11	.14	-.09
Psychoticism	.22	.33*	.27*	.33*	.10
Global severity	.21	.32*	.19	.30*	.02

* $p < .01$

Although these findings suggested that greater practice time is associated with increases in mindfulness and well-being and decreases in stress and symptoms, it was important to consider whether pre-treatment levels of mindfulness or psychological functioning were related to participants' likelihood of engaging in their assigned homework exercises. Correlations were therefore computed between total formal practice time during the intervention and pre-treatment scores on the mindfulness facets, perceived stress, medical and psychological symptoms, and well-being. These correlations were non-significant, suggesting that participants' pre-treatment levels of these variables had no significant effect on the amount of assigned home mindfulness practice they reported doing.

Mediation analyses

Because the findings suggested that engaging in formal mindfulness practices was associated with improvements in both mindfulness and symptoms/well-being, our third goal was to test the hypothesis that increases in mindfulness mediate the relationship between reported minutes spent in practice and improved psychological functioning. To examine this question we conducted three mediation analyses using the methods based on linear regression described by Baron and Kenny (1986), supplemented with

methods described by MacKinnon et al. (2000). In each case the independent variable (IV) was total formal practice time over the course of the program, created by summing the practice times (coded 0–10 as described earlier) for body scan, sitting meditation, and yoga. Informal practice time was not included in this variable because it was not significantly correlated with changes in other variables. The proposed mediating variable was the degree of change in mindfulness from pre- to post-intervention and was created by summing the pre-post change scores for the *observing*, *acting with awareness*, *non-judging*, and *non-reactivity* facets. The *describing* facet was not included in this variable because it was not significantly correlated with practice time. The dependent variables (DV) for the three mediation analyses were pre-post change scores for psychological symptoms (BSI-global severity index), perceived stress (PSS total score), and psychological well-being (PWB total score), respectively.

According to Baron and Kenny (1986), several conditions must be met to show support for a mediational hypothesis. The IV, mediator, and DV all must be significantly inter-correlated. When the IV and the mediator are entered simultaneously into a model predicting the DV, the relationships between the IV and DV must become non-significant, or must be significantly reduced. For the first mediation analysis, in which decrease in psychological

symptoms was the dependent variable, all conditions were met. Meditation practice time was a significant predictor of decrease in psychological symptoms ($R = .30$, $F = 11.39$, $p < .01$), and of increase in mindfulness ($R = .42$, $F = 21.95$, $p < .001$). Increase in mindfulness also was a significant predictor of decrease in symptoms ($R = .49$, $F = 46.50$; $p < .001$). When formal practice time and increase in mindfulness were entered simultaneously as predictors of decrease in symptoms, the regression coefficient for practice time dropped to .10 (ns). According to the formula described by MacKinnon et al. (2000), the drop in the regression coefficient from .30 to .10 is significant ($t = 3.57$, $p < .01$). This result is consistent with the hypothesis that the relationship between practice time and psychological symptoms is completely mediated by increases in mindfulness skills. This analysis can be seen in Fig. 1a.

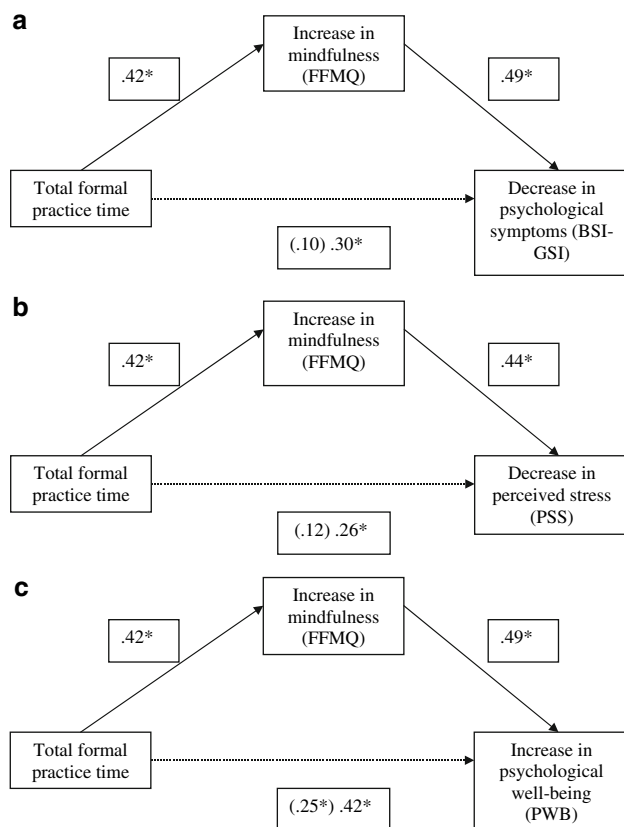


Fig. 1 Mediation of the relationship between formal meditation practice time and pre-post decrease in psychological symptoms as measured by the BSI-GSI (a), pre-post decrease in perceived stress as measured by the PSS (b), and pre-post increase in psychological well-being as measured by the PWB total score (c). In each case, the mediating variable is the sum of pre-post change scores in the *observing, acting with awareness, nonjudging, and nonreactivity* facets of mindfulness. All values are beta coefficients. Values in parentheses show relationships between formal practice time and the dependent variable, when the mediating variable is included in the model. * $p < .01$

A similar pattern was found for the second mediation analysis, in which decrease in perceived stress was the dependent variable. (Fig. 1b). In this case, meditation practice time was a significant predictor of decrease in perceived stress ($R = .26$, $F = 8.30$, $p < .01$) and of increase in mindfulness ($R = .42$, $F = 21.95$, $p < .001$). Increase in mindfulness also was a significant predictor of decrease in perceived stress ($R = .44$, $F = 34.74$, $p < .001$). When formal practice time and increase in mindfulness were entered simultaneously as predictors of decrease in perceived stress, the regression coefficient for practice time dropped significantly ($t = 2.77$, $p < .01$) to .12 (ns), suggesting that the relationship between practice time and perceived stress also is completely mediated by the development of mindfulness skills.

For increase in psychological well-being, only partial mediation was shown (Fig. 1c). In this case, meditation practice time was a significant predictor of well-being ($R = .42$, $F = 24.14$, $p < .001$) and of increase in mindfulness ($R = .42$, $F = 21.95$, $p < .001$). Increase in mindfulness also was a significant predictor of well-being ($R = .49$, $F = 45.95$, $p < .001$). However, when practice time and increase in mindfulness were entered simultaneously as predictors of well-being, the relationship between practice time and well-being remained significant, although the drop in the regression coefficient from .42 to .25 was significant ($t = 3.87$, $p < .01$). This finding suggests that, although increases in mindfulness are important in accounting for improvements in well-being, other variables not included in the model may also be important in accounting for increased well-being.

Discussion

The first goal of this study was to investigate whether participation in MBSR would lead to changes in levels of mindfulness as measured by the FFMQ. If such changes were observed, the second goal was to examine whether extent of home practice of mindfulness meditation was related to changes in mindfulness as well as changes in symptoms and well-being. Finally, if these relationships were found, the third goal was to explore whether increases in mindfulness mediate the relationship between meditation practice and improvements in functioning. Results showed that levels of mindfulness increased significantly from pre- to post-MBSR, with effect sizes in the moderate to large range. Results also showed that the extent of home practice of formal meditation exercises (body scan, yoga, sitting) is significantly correlated with degree of change in most facets of mindfulness (all but *describing*), and several measures of symptoms and well-being, although informal mindfulness practice (doing routine activities mindfully)

was unrelated to these outcomes. Finally, increases in mindfulness were shown to completely mediate the relationships between meditation practice over the course of the intervention and improvement in psychological symptoms and perceived stress, suggesting that the improvements in mindfulness that appear to result from regular practice are related to the significant reductions in psychological distress and perceived stress that were observed. Because perceived stress and symptom scores were significantly inter-correlated at both pre- and post-intervention, it is not surprising that mediation analyses for these two variables showed similar findings. Psychological well-being also was significantly intercorrelated with stress and symptoms, yet only partial mediation was shown for this variable, suggesting that other variables not measured here are important in accounting for the relationship between formal practice time and increased well-being.

These findings are important because they provide initial support for a central tenet of several mindfulness-based treatment approaches: that the regular practice of meditation should cultivate mindfulness skills in everyday life, which in turn should lead to improved psychological functioning such as symptom reduction, reduced stress and enhanced well-being. While this expectation is well established in the Buddhist meditation traditions upon which these programs draw, there is limited empirical evidence for the claim in clinical settings (Ramel et al. 2004; Toneatto and Nguyen 2007) and this is the first study to report these associations with a large sample in a clinical context. An alternative explanation—that more mindful people are more likely to practice meditation—was not supported by our findings, which showed non-significant relationships between baseline levels of mindfulness and extent of home practice during the intervention. The findings also provide encouraging support for the validity and utility of the FFMQ in measuring mindfulness. While significant improvements were noted in the *describing* factor of the FFMQ, these changes were not significantly associated with reported practice. This may be because MBSR training does not emphasize verbal labeling of the components of experience to the extent seen in some other mindfulness-based interventions, such as DBT and ACT, which include exercises for labeling of emotions, cognitions, and sensations.

An unexpected finding was the strong association between the mindful yoga form of practice and changes in other variables, including increased mindfulness skills, reduced symptoms, and improved well-being. Practice time for mindful yoga was significantly correlated with more of these variables than were practice times for the body scan or sitting meditation, and yoga was the only formal practice significantly related to increases in the non-judging facet of mindfulness and the global severity index of the

BSI. Given that mindful yoga was practiced on fewer days and for fewer total hours than the other formal practices, these results are striking and bear further investigation. As the body scan is assigned for daily practice during the first two weeks and is also a somatically-oriented practice, it may be that the time participants spent in practice of the body scan prepared them to be more mindful of their bodily sensations during the yoga, and hence obtained more benefit from the yoga practice than if they had come to it without prior mindfulness practice. It may also be easier for participants to bring mindful attention to the body while it is moving or stretching as the yoga requires, than while it is still as in the body scan or sitting meditation, and this feature may also facilitate the transfer of the resultant mindfulness into everyday life. The considerably higher average number of reported minutes of body scan practice than the average yoga and sitting practice may represent the initial novelty of practice in the early weeks of participation in the program, which may have waned over subsequent weeks.

Another unexpected finding was the lack of significant relationships between informal practice (doing routine activities mindfully) and extent of change in other variables. Informal practice is often described as an important method for generalizing mindfulness skills learned in formal practices into daily life (Kabat-Zinn 1990). Since no audio recordings are provided to guide informal practice, it is possible that participants in this study had difficulty in providing accurate estimates of the time they spent in informal practice. Better methods of monitoring this type of practice may be helpful in future studies as well as a more detailed investigation of the importance of ‘living mindfully’ on health and well-being outcomes.

Several symptom measures, including the Medical Symptom Checklist and several scales of the BSI, showed significant improvements from pre- to post-MBSR that were not correlated with the amount of home practice of any of the mindfulness exercises. Home practice is not the only mechanism by which improvements may be obtained in MBSR and it is possible that reductions in these symptoms can be attributed to other potentially important factors not measured here, such as social support from other group members, caring attention from the group leader, the effect of mindfulness together with the physical exercise that comes from yoga, or improved ability to relax. Further, a person who undertakes the commitment of a course such as MBSR may also be motivated to concurrently practice other mind-body techniques or to change or improve other health-related behaviors such as medication and treatment compliance for existing medical or psychological conditions. Future research should attempt to measure these variables, so that other potential mechanisms of change can be studied.

The following limitations of the study should be considered. Most of the participants were well educated, had the financial resources to pay for the treatment and had agreed to take part in a meditation-based program. It cannot be assumed that these findings can be generalized to other populations. In addition, the reported home practice figures should be interpreted with some caution. These analyses included only those participants ($N = 121$) who provided some or all of their practice data, and values of zero were entered for days for which practice records were not completed. Although instructors did not look at these forms, which were filed by research assistants, participants may have been less likely to complete a practice form for weeks in which they engaged in less homework practice. Thus, if all homework sheets had been completed, average daily practice times might have been lower. On the other hand, if the missing homework sheets had been turned in, and had included values greater than zero, then the figures for total practice time would have been higher. Thus, the figures we used are probably conservative estimates of practice time. In addition, a very small number of reported practice times were extremely high (e.g., 100–300 min of a single exercise on a single day). Because there was no significant correlation between reported practice time and baseline symptom levels, it does not appear that the more severely impaired participants were more likely to practice. Thus, the reasons for these unusual practice times are unclear.

The lack of a control group for this study is also a limitation. The efficacy of MBSR in reducing psychological distress and symptoms of stress has however been shown in previous controlled studies (Shapiro et al. 1998; Speca et al. 2000; Grossman et al. 2004). While the dependent variables in the mediation analysis were changes in symptoms and well-being the primary focus of the study was an examination of the relationships between home practice of mindfulness exercises and change in these outcomes, as well as the relationship of home practice to changes in levels of mindfulness. This latter relationship has not previously been reported. Never the less, the lack of another behavioral program as a suitable control intervention means that our study sheds no light on whether other interventions would result in similar changes. Other stress reduction programs may not require meditation, but they are likely to involve the practice of relaxation and/or cognitive restructuring and it is not known whether such practices lead to increases in mindfulness. Therefore future research should compare MBSR to other stress reduction programs to clarify whether the suggested mechanisms leading to improvement are unique to MBSR and also to assess the potential confounding impact of other health-related behaviors that may also change in participants motivated to undertake such programs.

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