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Mindfulness-based stress reduction for chronic pain conditions: Variation in treatment outcomes and role of home meditation practice

Steven Rosenzweig[a], Jeffrey M. Greeson[b,*], Diane K. Reibel[c], Joshua S. Green[d], Samar A. Jasser[e], Denise Beasley[c]

[a]*Office of Educational Affairs, Drexel University College of Medicine, Philadelphia, PA, USA*
[b]*Duke Integrative Medicine, Duke University Medical Center, Durham, NC, USA*
[c]*Jefferson-Myrna Brind Center of Integrative Medicine, Thomas Jefferson University Hospital, Philadelphia, PA, USA*
[d]*Department of Psychiatry and Human Behavior, Jefferson Medical College, Thomas Jefferson University Hospital, Philadelphia, PA, USA*
[e]*Department of Psychiatry and PENN Behavioral Health, University of Pennsylvania, Philadelphia, PA, USA*

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Abstract

Objective: This study compared changes in bodily pain, health-related quality of life (HRQoL), and psychological symptoms during an 8-week mindfulness-based stress reduction (MBSR) program among groups of participants with different chronic pain conditions. **Methods:** From 1997-2003, a longitudinal investigation of chronic pain patients (n=133) was nested within a larger prospective cohort study of heterogeneous patients participating in MBSR at a university-based Integrative Medicine center. Measures included the Short-Form 36 Health Survey and Symptom Checklist-90-Revised. Paired t tests were used to compare pre–post changes on outcome measures. Differences in treatment effect sizes were compared as a function of chronic pain condition. Correlations were examined between outcome parameters and home meditation practice. **Results:** Outcomes differed in significance and magnitude across common chronic pain conditions. Diagnostic subgroups of patients with arthritis, back/neck pain, or two or more comorbid pain conditions demonstrated a significant change in pain intensity and functional limitations due to pain following MBSR. Participants with arthritis showed the largest treatment effects for HRQoL and psychological distress. Patients with chronic headache/migraine experienced the smallest improvement in pain and HRQoL. Patients with fibromyalgia had the smallest improvement in psychological distress. Greater home meditation practice was associated with improvement on several outcome measures, including overall psychological distress, somatization symptoms, and self-rated health, but not pain and other quality of life scales. **Conclusion:** MBSR treatment effects on pain, HRQoL and psychological well-being vary as a function of chronic pain condition and compliance with home meditation practice.

Keywords: Chronic pain; Compliance; Effect size; Health-related quality of life; Meditation; Mindfulness-based stress reduction; Psychological distress

Introduction

An estimated one in three people suffer from chronic pain, a condition frequently associated with decreased health-related quality of life (HRQoL) and high levels of psychological distress [1]. Despite conventional healthcare utilization, nearly half of patients with chronic pain report their pain as not under control [2]. Limitations of drug therapy for chronic pain reflect the complex pathophysiology of the condition, as well as the profound contribution of psychosocial factors to the perpetuation of pain and suffering [3,4]. Mind–body medicine is defined by a range of therapies intended to enhance the mind's capacity to improve bodily function and symptoms [5]. Despite consensus that mind–body therapies can be effectively

* Corresponding author. Duke Integrative Medicine, Duke University Medical Center, DUMC Box 102904, Durham, NC 27710, USA. Tel.: +1 919 660 6773; fax: +1 919 684 6445.
E-mail address: jeffrey.greeson@duke.edu (J.M. Greeson).

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incorporated into comprehensive management of chronic pain, only 20% of chronic pain patients report using such interventions in the past year [6,7]. A better understanding of the effectiveness of particular mind–body therapies for specific patient subpopulations may support wider and more successful integration of mind–body medicine with conventional pain management [8].

Mindfulness-based stress reduction (MBSR) is a group intervention that appears to be a promising adjunct to treating chronic pain and attendant reduction in physical functioning and psychological well-being [9–11]. The core of MBSR is intensive training in mindfulness meditation and its applications for daily living and coping with stress, illness, and pain [12,13]. Mindfulness meditation is the practice of paying attention, on purpose, moment-to-moment, in a way that is nonjudgmental and nonreactive. Practitioners report greater equanimity and less distress secondary to uncomfortable sensations, thoughts, and emotions [10,11,14].

A series of early treatment outcome studies found that MBSR program participants with various self-reported chronic pain conditions demonstrated significant changes in pain intensity, medical symptoms, psychological symptoms, coping ability, and inhibition of daily activity by pain, most of which were superior to standard medical care alone and persisted up to four years later [15–17]. Another descriptive study of patients with heterogeneous chronic pain conditions reported significant changes in self-report measures of pain, pain beliefs, and psychological symptoms following MBSR combined with conventional medical treatment [18]. The mean posttreatment effect size (d=.15) in the latter study, however, was substantially smaller than the MBSR effect sizes reported previously for chronic pain patients (.36<d<.70) [10]. Therefore, it remains to be determined whether the health benefits of MBSR in mixed diagnosis pain cohorts generalize across study sites.

Investigators have also studied MBSR for groups of patients diagnosed with a common chronic pain condition. Studies of fibromyalgia patients have demonstrated improvements in pain, anxiety, depression, somatic complaints, sense of coherence, global well-being, coping, sleep quality, and fatigue [19–22]. A waitlist controlled trial of rheumatoid arthritis patients reported no difference in disease activity but did not include pain as an outcome measure [23]. A randomized trial of patients with chronic musculoskeletal pain found that MBSR effects on pain intensity did not differ significantly from massage therapy or standard medical care; however, MBSR uniquely improved psychological well-being at follow-up [24]. Finally, a randomized clinical trial of MBSR for older adults with chronic low back pain found significant improvement in pain acceptance, and for one of three measures of physical functioning, but not for pain intensity [25].

Given these mixed empirical findings, more needs to be known about the effectiveness of MBSR in chronic pain conditions, especially in relation to specific pain conditions. A neglected but potentially important methodological consideration is whether or not MBSR is taught to a medically heterogeneous or homogeneous patient population. MBSR programs generally serve mixed cohorts of patients who may or may not have chronic pain or share a medical condition. Studying MBSR for medically homogeneous cohorts may introduce unmeasured, confounding group effects.

The primary aim of this study, therefore, was to compare MBSR treatment effects among subgroups of patients with different chronic pain conditions who participated in an MBSR program offered to a medically heterogeneous community population. Outcomes were HRQoL, including an index of bodily pain and pain-related limitations in daily functioning, and psychological distress, including measures of anxiety, depressive symptoms, somatization, and overall psychological distress level. Secondarily, because relatively little is known about the processes of therapeutic change during MBSR, the relationship between intervention outcomes and adherence to formal home meditation practice was assessed.

Materials and methods

Design and procedure

This study used a prospective cohort design to assess changes in bodily pain, HRQoL, and psychological symptoms during an MBSR program modeled after the curriculum developed by Kabat-Zinn et al. at the Stress Reduction Clinic of the University of Massachusetts Medical Center [26]. The intervention took place at a large academic medical center (Thomas Jefferson University Hospital, Philadelphia, PA, USA) where study participants were recruited through local medical clinics and media advertisements. Participants were both physician- and self-referred. All participants underwent a one-on-one intake interview prior to enrollment in MBSR during which a brief medical history was taken, course expectations were communicated, and informed consent was obtained for participation in outcome research. This study includes all MBSR program participants who reported one or more chronic pain conditions during the intake interview. The study protocol was approved by the Thomas Jefferson University Institutional Review Board.

The present study of individuals with chronic pain was nested within a larger prospective study of heterogeneous patients (n=450) participating in MBSR through the Jefferson-Myrna Brind Center of Integrative Medicine from 1997 to 2003. Participation in Jefferson's MBSR program was open to anyone interested in exploring the potential health benefits of meditation practice. Persons were excluded and referred for appropriate healthcare services if they reported severe psychopathology during the intake interview, such as psychotic symptoms, active

suicidality, or ongoing substance abuse or dependence. All MBSR program participants, including those with chronic pain, continued to receive usual medical care throughout the intervention.

Study participants

During the study period, 133 participants in Jefferson's MBSR program presented with chronic pain defined as six months duration or longer. Of these 133 persons, 51 presented with chronic neck and/or back pain, making these the most prevalent pain conditions. In descending order of frequency, other pain conditions included chronic headaches/migraines (n=34), arthritis (n=32), fibromyalgia (n=27), and variable other conditions of lesser prevalence (e.g., reflex sympathetic dystrophy). Fifty-two participants (39%) presented with two or more comorbid pain conditions. The mean duration of self-reported pain was 12.1 (S.D.=10.2) years.

One hundred eleven (84%) individuals reporting chronic pain were women. One hundred twenty-three participants (93%) were Caucasian, six (5%) were African-American, and three were of another ethnicity (3%). Age ranged from 23 to 78 years, with a mean of 49.8 years. Eighty-nine participants (67%) reported a college degree or postgraduate education; only one participant reported less than 12 years of education. Seventy-two participants (54%) reported that their occupational status was active (i.e., working full-time, working part-time, enrolled as a student, or homemaker); 32 participants (24%) reported they were disabled; 16 participants (12%) reported they were retired; and five (4%) were unemployed. Forty-seven percent of the sample was married, 24% was single, 17% was separated or divorced, and 7% was widowed.

Intervention

Standard 8-week MBSR courses were taught six times per year by professionally trained MBSR instructors who were themselves long-term meditators [26]. Instructors taught a variety of mindfulness meditation techniques, including: body scan, awareness of breathing, awareness of emotions, mindful yoga and walking, mindful eating, and mindful listening. The core curriculum of the intervention remained consistent over the 7-year data collection period. As part of the program, participants were instructed to practice 20–25 min of formal meditation daily, 6 days per week. This formal mindfulness practice was in addition to the informal practice of being mindful in everyday activities. Weekly class time lasted 2.5 hours and was divided between meditation practice, small and large group discussions, and mindfulness skill-building activities. Additionally, the course included 1 full day (7 hours) of practice on the weekend of the 6th week. Written materials and audio CDs of guided meditations were provided to support home practice.

Outcome measures

Two standardized assessment instruments were administered before (pre) and after (post) the 8-week MBSR training course to evaluate treatment outcomes:

(1) Medical Outcomes Study Short-Form 36 Health Survey (SF-36). The SF-36 was used to measure HRQoL outcomes. The SF-36 is widely used in allopathic outcome studies, and validity and reliability for the instrument have been demonstrated in several chronic illness populations [27]. This 36-item questionnaire reports both physical and mental functioning and well-being. It includes one multi-item scale measurement for each of eight health concepts: (1) physical functioning (PF); (2) role limitations due to physical health problems (RP); (3) bodily pain (BP); (4) general health perception (GH); (5) vitality/fatigue; (VT); (6) social functioning (SF); (7) role limitations due to emotional problems (RE); and (8) mental health status (MH). Higher scores on a scale of 0–100 represent greater functionality and well-being; therefore, higher scores on the bodily pain measure represent less severe and less debilitating pain. Two summary scales are also calculated [28]. The Physical Component Summary represents the four most physically-weighted scales (in descending order: PF, RP, BP, GH). The Mental Component Summary represents the four most psychologically-weighted scales (in descending order: MH, RE, SF, VT).
(2) Symptom Checklist-90-Revised (SCL-90-R). The SCL-90-R is a valid and reliable instrument that is sensitive to changes in psychological distress [29]. This 90-item inventory consists of nine symptom dimensions and a summary score that combine information on the number of symptoms reported and intensity of perceived distress for each symptom. The SCL-90-R has been shown to correlate well with comparable scales on the Minnesota Multiphasic Personality Inventory [30]. Scores for anxiety (ANX), depression (DEP), and somatization (SOM) are reported here, along with the Global Severity Index (GSI) score which represents overall psychological distress.

Midway through the study, we began to administer daily home practice logs in order to comprehensively assess formal meditation practice at home. These logs allowed participants to record the date, time, type, and duration of formal home practice along with any comments on their experience. A protocol adherence variable was derived from these daily practice forms representing average weekly time spent in formal meditation practice during the 8-week MBSR program. Informal mindfulness practice was not measured.

Data analysis

Data were analyzed using SPSS version 12.0 (SPSS, Chicago, IL, USA). Paired *t* tests (two-tailed, α=.05) were performed to compare pre- and postintervention scores on standardized outcome instruments. Cohen's *d* effect size for paired observations, also known as the standardized response mean [31], was used to estimate the magnitude of treatment-related effects. Pearson product-moment correlations were calculated to examine associations between change scores (postintervention minus pre-intervention) and compliance with home meditation practice during MBSR training.

Results

Preintervention assessment demonstrated marked functional limitations and psychological morbidity. The cohort scored below the 25th percentile of the general US population norm on all eight SF-36 indices, indicating substantially compromised HRQoL [27]. Furthermore, the study sample placed above the 80th percentile on all SCL-90-R subscales relative to the general US population, demonstrating considerable psychological distress [29].

Weekly class attendance information was available for 95% of study participants. Program completion was defined as having attended at least six of eight total sessions. One hundred individuals (79%) completed the program, a rate consistent with that reported by Kabat-Zinn et al. [32]. Of the remaining study participants, three attended five classes, one attended three classes, and six had incomplete attendance records. Overall, pre- and postintervention data were available for 99 MBSR program completers.[1]

Table 1 presents a summary of HRQoL and psychological distress outcome data stratified by chronic pain condition. First, patient subgroup analyses revealed that HRQoL outcomes differed substantially across chronic pain conditions. Specifically, MBSR completers who reported arthritis pain at intake (*n*=24) demonstrated significant improvement on seven of eight SF-36 subscales, including BP, and showed the largest average change in HRQoL during MBSR (mean *d*=.67). MBSR participants who reported back or neck pain (*n*=35) showed significant improvement on six of eight SF-36 indices, including BP (mean d=.52). MBSR participants with fibromyalgia (*n*=11) who completed the program experienced improvement on three of eight HRQoL measures (mean *d*=.49). The subgroup of individuals that reported chronic headache/migraine (*n*=15) had significant improvement on only two of eight SF-36 scales and showed the smallest magnitude change in HRQoL (mean *d*=.41). Participants who reported two or more comorbid pain conditions (*n*=30) improved on five of eight SF-36 subscales, including BP (mean d=.60). Overall, treatment effect sizes on HRQoL across chronic pain conditions fell within the medium range (mean *d*'s between .41 and .67; see Table 1).

Comparison of treatment effects across SCL-90-R subscales revealed that chronic pain subgroups generally experienced medium to large magnitude reductions in symptoms of psychological distress (mean *d*'s between .53 and .86; see Table 1). The one exception was that patients with fibromyalgia who, as a group, experienced a small to medium reduction in distress (mean *d*=.39). Patients with back/neck pain, arthritis, and comorbid pain conditions experienced significant improvements on all four SCL-90-R subscales, including ANX, DEP, SOM, and overall psychological distress (see Table 1). Patients with chronic headache/migraine showed significant changes on three of four SCL-90-R subscales. Patients with fibromyalgia did not show statistically significant improvement on any SCL-90-R measure.

For the full sample of MBSR program completers (*n*=99) who reported one or more chronic pain diagnoses, paired *t* tests revealed statistically significant changes ($P<.05$) on all eight SF-36 subscales. Moreover, each SF-36 subscale improved by five points or more, indicative of clinically relevant change [27]. Medium to large effect sizes were observed on SF-36 measures of bodily pain, general health perception, vitality, social functioning, and mental health status (*d*'s between .51 and .80; see Table 1). Small to medium effect sizes were observed on SF-36 measures of physical functioning, role limitations due to physical health problems, and role limitations due to emotional problems (*d*'s between .26 to .48; see Table 1). In addition to improvements in HRQoL, the chronic pain sample as a whole demonstrated significant reductions ($P<.05$) in psychological distress during MBSR training. As shown in Table 1, medium to large magnitude effects were found across the four SCL-90-R subscales (*d*'s between .50 and .80). The mean GSI score measuring overall psychological distress was reduced by 33%. Similarly, SCL-90-R subscale scores for ANX, DEP, and SOM were reduced by 39%, 30%, and 21%, respectively.

Daily home meditation practice records were available to track protocol adherence for 41 of 99 MBSR program completers. Adherence data were unavailable for remaining subjects due to midstudy initiation of a data collection

[1] Independent-samples *t* tests on baseline data revealed that compared to subjects who completed the intervention, noncompleters reported significantly more somatization (t_{109}=2.28, $P<.05$) and role limitations due to emotional problems (t_{119}=2.52, $P<.05$). Noncompleters did not significantly differ from the group of MBSR program completers on any other SF-36 or SCL-90-R subscales or on demographic characteristics such as age or proportion of women or ethnic minority members.

Notes to Table 1:

[a] A 5-point change is clinically significant [27].

[b] Mean effect size based on the eight SF-36 subscales.

* $P\leq.05$ for paired, two-tailed *t* test with pre-intervention mean.

† $P\leq.10$ for paired, two-tailed *t* test with pre-intervention mean.

‡ Standardized response mean calculated as: (difference between pre- and post scores)/(SD of difference score). Interpretative ranges: 0.20=small, 0.50=medium, 0.80=large [33].

Table 1
Pre- and post-MBSR mean (S.D.) scores and effect sizes on the SF-36 and SCL-90-R stratified by chronic pain condition

Outcomes measures	Full sample (*n*=99)	Back/neck pain (*n*=35)	Arthritis (*n*=24)	Headache/migraine (*n*=15)	Fibromyalgia (*n*=11)	Comorbid pains (*n*=30)
SF-36 Health Survey[a]						
Physical functioning						
Pre	61.75 (31.39)	60.14 (33.33)	51.98 (31.28)	76.33 (28.75)	54.29 (24.53)	50.57 (31.16)
Post	66.75 (30.08)*	64.71 (31.85)	58.75 (30.07)*	78.67 (28.75)	54.29 (26.67)	55.33 (30.71)†
Effect size‡	0.33	0.27	0.68	0.14	0.00	0.34
Role-physical						
Pre	34.34 (41.43)	32.86 (42.78)	35.87 (43.19)	50.00 (45.32)	13.64 (20.50)	26.67 (42.51)
Post	51.52 (43.42)*	52.86 (42.78)*	46.74 (44.79)	65.00 (48.00)	20.45 (35.03)	34.17 (41.25)†
Effect size	0.48	0.55	0.29	0.41	0.19	0.34
Bodily pain						
Pre	40.86 (23.39)	38.85 (24.26)	40.39 (24.77)	47.80 (27.44)	34.50 (13.26)	31.77 (20.91)
Post	50.30 (23.77)*	48.71 (24.81)*	46.83 (21.41)*	55.20 (25.65)	42.60 (17.89)	40.90 (20.18)*
Effect size	0.56	0.69	0.43	0.29	0.48	0.69
General health perception						
Pre	47.78 (25.27)	46.18 (24.26)	41.64 (23.24)	57.64 (26.15)	28.20 (13.05)	34.00 (20.44)
Post	55.01 (24.53)*	51.31 (24.69)*	51.86 (23.53)*	61.86 (24.26)	42.60 (22.27)*	42.08 (21.69)*
Effect size	0.51	0.46	0.82	0.26	0.74	0.75
Vitality						
Pre	33.60 (22.90)	33.28 (25.19)	31.23 (23.06)	33.67 (16.85)	18.89 (17.28)	22.53 (19.86)
Post	47.40 (22.71)*	45.49 (24.38)*	48.33 (21.27)*	46.67 (21.85)*	37.22 (23.60)*	38.99 (21.65)*
Effect size	0.80	0.64	0.88	1.06	0.96	1.11
Social functioning						
Pre	56.25 (28.96)	54.41 (33.13)	58.15 (27.60)	50.83 (30.05)	48.75 (22.40)	46.67 (29.71)
Post	66.15 (27.66)*	66.54 (28.99)*	64.48 (26.35)*	55.00 (28.27)	60.00 (28.75)†	56.67 (25.58)*
Effect size	0.51	0.58	0.54	0.25	0.59	0.50
Role-emotional						
Pre	51.85 (43.44)	51.43 (44.53)	50.72 (42.49)	44.44 (44.84)	57.58 (44.95)	48.89 (48.53)
Post	63.30 (41.92)*	60.00 (43.39)	73.91 (40.15)*	57.78 (42.67)	45.45 (42.88)	53.33 (44.29)
Effect size	0.26	0.19	0.68	0.28	0.24	0.09
Mental health						
Pre	55.66 (19.78)	54.59 (20.70)	52.75 (18.09)	53.33 (19.63)	60.80 (23.23)	50.80 (21.96)
Post	67.40 (17.53)*	64.47 (18.60)*	71.83 (17.20)*	61.07 (16.52)*	68.27 (19.77)*	64.49 (19.17)*
Effect size	0.79	0.77	1.00	0.62	0.71	0.98
Physical summary						
Pre	37.47 (12.74)	36.16 (13.39)	35.42 (12.06)	45.08 (13.24)	30.12 (7.91)	32.59 (12.51)
Post	40.37 (12.83)*	39.63 (13.32)*	36.26 (12.53)	46.99 (11.84)	34.17 (10.43)	34.63 (11.94)†
Effect size	0.41	0.44	0.16	0.25	0.41	0.35
Mental summary						
Pre	39.91 (12.41)	39.52 (13.59)	51.98 (31.28)	35.31 (11.41)	40.80 (12.92)	37.33 (13.92)
Post	45.98 (11.21)*	44.82 (11.37)*	58.75 (30.07)*	40.41 (9.96)*	43.73 (12.63)	43.64 (10.86)*
Effect size	0.67	0.63	1.13	0.62	0.30	0.68
Mean Effect Size for SF-36[b]	0.53	0.52	0.67	0.41	0.49	0.60
SCL-90-R						
Global severity index						
Pre	0.91 (0.63)	1.04 (0.75)	0.85 (0.50)	0.93 (0.78)	0.75 (0.32)	1.18 (0.79)
Post	0.61 (0.53)*	0.73 (0.64)*	0.54 (0.47)*	0.66 (0.56)*	0.57 (0.33)	0.88 (0.70)*
Effect size	0.80	0.87	0.98	0.63	0.55	0.72
Anxiety subscale						
Pre	0.91 (0.72)	1.08 (0.83)	0.84 (0.72)	0.99 (0.79)	0.50 (0.25)	1.13 (0.89)
Post	0.55 (0.56)*	0.64 (0.65)*	0.45 (0.52)*	0.70 (0.66)*	0.46 (0.32)	0.74 (0.73)*
Effect size	0.72	0.75	0.87	0.60	0.19	0.70
Depression subscale						
Pre	1.24 (0.84)	1.39 (0.94)	1.25 (0.64)	1.22 (1.15)	0.88 (0.54)	1.53 (0.95)
Post	0.85 (0.71)*	0.99 (0.78)*	0.78 (0.67)*	0.89 (0.89)	0.66 (0.40)	1.13 (0.78)*
Effect size	0.66	0.78	0.88	0.44	0.39	0.68
Somatization subscale						
Pre	1.04 (0.72)	1.23 (0.83)	0.99 (0.67)	0.79 (0.51)	0.96 (0.61)	1.39 (0.87)
Post	0.79 (0.63)*	0.99 (0.77)*	0.75 (0.61)*	0.56 (0.35)†	0.85 (0.53)	1.14 (0.75)*
Effect size	0.50	0.52	0.61	0.53	0.14	0.45
Mean effect size for SCL-90-R	0.69	0.75	0.86	0.53	0.39	0.68

protocol for this measure. Among participants for whom home meditation practice data were available, the mean number of meditation sessions per week was six (S.D.=3), and the average time spent in meditation per day was 20 min (S.D.=14). Thus, self-reported adherence with MBSR program requirements was congruent with expectations communicated during the pre-enrollment interview. Correlational analyses revealed that greater average weekly home meditation practice was significantly associated with greater reduction in overall psychological distress (GSI: r=−.40, P<.05, n=31) and somatization symptoms (SOM: r=−.50, P<.05, n=29), as well as with an increase in self-rated general health (GH: r=.42, P<.01, n=35). In addition, greater home practice tended to be associated with a greater reduction in role limitations due to emotional problems (RE: r=.30, P=.08, n=36) and with greater improvement in social functioning (SF: r=.31, P=.07, n=36). Self-reported home meditation practice did not correlate significantly with other outcomes, including changes in anxiety (ANX: r=−.14, P=.46, n=31), depression (DEP: r=-.29, P=.12, n=29), bodily pain (BP: r=.18, P=.29, n=36), or other quality of life subscales.

Discussion

In this study, observed improvements in bodily pain, HRQoL, and psychological distress for the full sample of heterogeneous chronic pain patients were consistent with previous findings reported by other investigators [15–18]. Similar to previous investigations of mind-body interventions for chronic pain, outcomes differed substantially as a function of specific pain condition [34].

Patients who reported chronic back/neck pain and patients who reported two or more comorbid pain conditions experienced the largest average improvement in pain severity and functional limitations due to pain; lesser improvements were found in patients with fibromyalgia, arthritis, and chronic headache/migraine. Pain reduction in participants with fibromyalgia were consistent with prior clinical investigations of MBSR for homogeneous groups of fibromyalgia patients [19,22]. Improvements in patient subgroups with various types of musculoskeletal pain (e.g., fibromyalgia, back/neck pain, arthritis) differed from the null findings of a pilot study of MBSR for musculoskeletal pain, which had limited statistical power since only five subjects completed MBSR training [24]. Our finding that a subgroup of patients with chronic headache/migraine reported non-significant changes in pain is consistent with the results of a recent randomized, controlled trial [35]. To our knowledge, the present study is the first to demonstrate that MBSR may be an effective adjunct for treating chronic pain associated with arthritis. Pain reduction in the arthritis subgroup is consistent with results reported for rheumatoid arthritis patients who received emotional regulation skills training in combination with mindfulness meditation practice [36].

While all subgroups of chronic pain patients reported meaningful average improvements in HRQoL, subgroups varied in terms of degree of change. Arthritis patients reported the largest average improvement in HRQoL, as well as the largest mean reduction in psychological distress. Patients with chronic back or neck pain showed medium to large effects on indicators of physical and mental HRQoL. Patients with chronic headache/migraine reported the smallest magnitude improvement in HRQoL following MBSR. Finally, MBSR participants who reported two or more chronic pain conditions benefited substantially in terms of improved pain and pain-related functional limitations, overall HRQoL, and psychological well-being.

A secondary aim was to examine the relationship between home meditation practice and variation in MBSR treatment outcomes for chronic pain patients. Among chronic pain patients for whom home practice data were available, better adherence to formal home meditation practice was associated with several intervention outcomes, including reduction in overall psychological distress and somatic symptoms, and improvement in self-rated health. Greater home practice tended to be associated with a reduction in role limitations due to emotional problems and with an improvement in social functioning. Home meditation practice, however, was not significantly correlated with changes in bodily pain, anxiety, depressive symptoms, or other HRQoL subscales such as physical functioning. To our knowledge, only one other study of MBSR for a chronic pain condition has examined the association between home meditation practice and treatment outcomes. Pradhan et al. [23] studied rheumatoid arthritis patients and observed a significant, positive association between improved psychological symptoms and frequency of home practice (days per week), but not total practice time (minutes per week). Numerous studies have found no or inconsistent associations between amount of home meditation practice and MBSR outcomes [37]. Our findings in this chronic pain sample support an emerging literature that suggests an inconsistent relationship between home meditation practice and MBSR treatment responses. An interesting, recent report examined amount and type of MBSR home practice (sitting meditation, body scan or mindful yoga) and found the strongest association between home yoga practice and better outcomes [38]. Particular benefits of yoga and other types of MBSR home practice needs to be studied in the chronic pain population.

Theoretically, patients with chronic pain may benefit from mindfulness practice through various pathways. First, both sensory and affective components of pain perception itself may be modulated through the self-regulation of attention, which can be cultivated by meditation practice [39–41]. Central nervous system pain perception pathways involving the amygdala and the anterior cingulate cortex may be inhibited or down-regulated with greater levels of mindfulness [42,43]. Second, similar to cognitive-behavioral therapies, mindfulness aims to reduce reactivity to distressing thoughts and feelings that accompany and amplify

pain experience [10]. Third, mindfulness has been shown to reduce psychological symptoms, including comorbid anxiety and depression, in various patient populations [44]. Negative emotional states may amplify suffering associated with pain perception [4]. Fourth, mindfulness enhances physical self-monitoring and body awareness, possibly leading to improved body mechanics and improved self-care. Fifth, relative to traditional relaxation training, mindfulness meditation is associated with greater parasympathetic activation, which can promote deep muscle relaxation and concomitant lessening of myofascial tension and irritability that may reduce pain [14,45]. Sixth, mindfulness may buffer against stress-related mood dysfunction and psychophysiological activation by enhancing cognitive coping processes, such as positive reappraisal [46], and by strengthening emotion regulation skills, such as distress tolerance [47].

Most MBSR programs are offered to mixed patient populations. Providing MBSR to a single-diagnosis patient group may introduce factors that effect outcomes. For example, the emotionally supportive dimension of group membership may be enhanced. Another possibility is that greater amounts of class instruction and discussion time may focus on the particularities of the specific medical condition. It is therefore important to assess the relative benefits of MBSR as it is usually taught to heterogeneous populations, as was done in this study, in addition to evaluating MBSR applied to homogeneous patient cohorts.

This study was limited in important ways. First, it was an observational study without a control group. Therefore, it is possible that study participants, on average, may have experienced spontaneous improvement in pain, functional status and psychological well-being that was not due to the intervention. However, given the refractory nature of chronic pain and the consistency of many self-report outcomes with previously published meta-analytic findings, the current study appears to lend additional support to the hypothesis that MBSR is clinically effective [3,10,11]. Second, only one direct measure of pain, the BP subscale of the SF-36 Health Survey, was used. Although the SF-36 pain subscale does capture both the intensity and activity interference associated with pain, future studies would benefit by including multidimensional pain assessment tools that also assess sensory and affective dimensions of pain, such as the McGill Pain Questionnaire [48]. Third, sample sizes were relatively small for specific chronic pain conditions, limiting statistical power and the reliability of effect size estimates, and fourth, given the demographic characteristics of this sample (primarily Caucasian women, well-educated, actively working), generalizability remains to be determined. Fifth, no direct comparison could be made to treatment effects for similar patients participating in MBSR programs for medically homogeneous patient cohorts.

In summary, this study found that while MBSR-related changes in physical and psychosocial variables appear to be clinically meaningful in patients with chronic and debilitating pain, specific outcomes within the same MBSR program can vary by diagnosis. Moreover, the results are the first to establish a correlation between home, formal meditation practice and the degree of clinical improvement on several outcome measures in a chronic pain cohort. Future studies with homogeneous chronic pain conditions are needed to clarify for whom MBSR is most and least effective and what underlying mechanisms account for variation in outcome.

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References

[1] National Center for Health Statistics. Health, United States, 2006 With Chartbook on Trends in the Health of Americans. Hyattsville, MD: 68–71.
[2] Chronic pain in America: roadblocks to relief, a study conducted by Roper Starch worldwide for American Academy of Pain Medicine, American Pain Society and Janssen Pharmaceutica, 1999.
[3] Ashburn MA, Staats PS. Management of chronic pain. Lancet 1999; 353:1865–9.
[4] Keefe FJ, Rumble ME, Scipio CD, Giordano LA, Perri LM. Psychological aspects of persistent pain: current state of the science. J Pain 2004;5:195–211.
[5] National Center for Complementary and Alternative Medicine (NCCAM), National Institutes of Health, U.S. Department of Health and Human Services. Mind-body medicine: an overview. NCCAM publication number D239, Updated May 2007.
[6] Integration of behavioral and relaxation approaches into the treatment of chronic pain and insomnia. NIH Technology Assessment Panel on Integration of Behavioral and Relaxation Approaches into the Treatment of Chronic Pain and Insomnia. JAMA 1996;276: 313–8.
[7] Wolsko PM, Eisenberg DM, Davis RB, Phillips RS. Use of mind-body medical therapies. J Gen Intern Med 2004;19:43–50.
[8] Astin JA. Mind-body therapies for the management of pain. Clin J Pain 2004;20:27–32.
[9] Teixeira ME. Meditation as an intervention for chronic pain: an integrative review. Holist Nurs Pract 2008;22:225–34.
[10] Baer RA. Mindfulness training as a clinical intervention: a conceptual and empirical review. Clin Psychol Sci Pract 2003;10:125–43.
[11] Grossman P, Niemann L, Schmidt S, Walach H. Mindfulness-based stress reduction and health benefits: a meta-analysis. J Psychosom Res 2004;57:35–43.
[12] Kabat-Zinn J. Mindfulness-based interventions in context: past, present and future. Clin Psychol Sci Pract 2003;10:144–56.
[13] Kabat-Zinn J. Full catastrophe living: using the wisdom of your body and mind to face stress, pain and illness. New York (NY): Dell Publishing, 1990.
[14] Greeson JM. Mindfulness research update: 2008. Compl Health Prac Rev 2009;14:10–8.
[15] Kabat-Zinn J. An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: theoretical considerations and preliminary results. Gen Hosp Psychiatry 1982;4:33–47.

[16] Kabat-Zinn J, Lipworth L, Burney R. The clinical use of mindfulness meditation for the self-regulation of chronic pain. J Behav Med 1985;8: 163–90.
[17] Kabat-Zinn J, Lipworth L, Burney R, Sellers W. Four year follow-up of a meditation-based program for the self-regulation of chronic pain: treatment outcomes and compliance. Clin J Pain 1986;2:159–73.
[18] Randolph PD, Caldera YM, Tacone AM, Greak BL. The long-term combined effects of medical treatment and a mindfulness-based behavioral program for the multidisciplinary management of chronic pain in West Texas. Pain Digest 1999;9:103–12.
[19] Kaplan RH, Goldenberg DL, Galvin-Nadeau M. The impact of a meditation-based stress reduction program on fibromyalgia. Gen Hosp Psychiatry 1993;15:284–9.
[20] Sephton SE, Salmon P, Weissbecker I, Ulmer C, Floyd A, Hoover K, Studts JL. Mindfulness meditation alleviates depressive symptoms in women with fibromyalgia: results of a randomized clinical trial. Arthritis Rheum 2007;57:77–85.
[21] Weissbecker I, Salmon P, Studts JL, Floyd AR, Dedert EA, Sephton SE. Mindfulness-based stress reduction and sense of coherence among women with fibromyalgia. J Clin Psychol Med Sett 2002;9:297–307.
[22] Grossman P, Tiefenthaler-Gilmer U, Raysz A, Kesper U. Mindfulness training as an intervention for fibromyalgia: evidence of postintervention and 3-year follow-up benefits in well-being. Psychother Psychosom 2007;76:226–33.
[23] Pradhan EK, Baumgarten M, Langenberg P, Handwerger B, Gilpin AK, Magyari T, Hochberg MC, Berman BM. Effect of mindfulness-based stress reduction in rheumatoid arthritis patients. Arthritis Rheum 2007;57:1134–42.
[24] Plews-Ogan M, Owens JE, Goodman M, Wolfe P, Schorling J. A pilot study evaluating mindfulness-based stress reduction and massage for the management of chronic pain. J Gen Intern Med 2005;20:1136–8.
[25] Morone NE, Greco CM, Weiner DK. Mindfulness meditation for the treatment of chronic low back pain in older adults: a randomized controlled pilot study. Pain 2008;134:310–9.
[26] Kabat-Zinn J, Santorelli S. Mindfulness-based stress reduction professional training resource manual. Worcester (Mass): Center for Mindfulness in Medicine, Health Care and Society, 1999.
[27] Ware JE, Kosinsky M, Gandek B. SF-36 Health Survey: manual and interpretation guide. Boston (Mass): The Health Institute, New England Medical Center, 1993.
[28] Ware JE, Kosinsky M, Keller SK. SF-36 Physical and mental health summary scales: a user's manual. Boston (Mass): Health Assessment Lab, New England Medical Center, 1994.
[29] Derogatis LR. SCL-90-R administration, scoring, and procedures manual. 3rd ed. Minneapolis (Minn): National Computer Systems, Inc., 1994.
[30] Derogatis LR. The SCL-90 and the MMPI: a step in the validation of a new self-report scale. Br J Psychiatry 1976;128:280–9.
[31] Middel B, van Sonderen E. Statistical significant change versus relevant or important change in (quasi) experimental design: some conceptual and methodological problems in estimating magnitude of intervention-related change in health services research. Int J Integr Care 2002;2:e15.
[32] Kabat-Zinn J, Chapman-Waldrop A. Compliance with an outpatient stress reduction program: rates and predictors of program completion. J Behav Med 1988;11:333–52.
[33] Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale (NJ): Lawrence Erlbaum Associates, Inc, 1988.
[34] Astin JA, Shapiro SL, Eisenberg DM, Forys KL. Mind-body medicine: state of the science, implications for practice. J Am Board Fam Pract 2003;16:131–47.
[35] Nash-Mc Feron DE. Mindfulness in the treatment of chronic headache pain. Dissertation Abstracts International 2006;67(5-B).
[36] Zautra AJ, Davis MC, Reich JW, Nicassario P, Tennen H, Finan P, Kratz A, Parrish B, Irwin MR. Comparison of cognitive behavioral and mindfulness meditation interventions on adaptation to rheumatoid arthritis for patients with and without history of recurrent depression. J Consult Clin Psychol 2008;76:408–21.
[37] Nyklícek I, Kuijpers KF. Effects of mindfulness-based stress reduction intervention on psychological well-being and quality of life: is increased mindfulness indeed the mechanism? Ann Behav Med 2008;35:331–40.
[38] Carmody J, Baer RA. Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. J Behav Med 2008;31:23–33.
[39] Cahn BR, Polich J. Meditation states and traits: EEG, ERP, and neuroimaging studies. Psychol Bull 2006;132:180–211.
[40] Lutz A, Slagter HA, Dunne JD, Davidson RJ. Attention regulation and monitoring in meditation. Trends Cogn Sci 2008;12:163–9.
[41] Kingston J, Chadwick P, Meron D, Skinner TC. A pilot randomized control trial investigating the effect of mindfulness practice on pain tolerance, psychological well-being, and physiological activity. J Psychosom Res 2007;62:297–300.
[42] Karp JF, Shega JW, Morone NE, Weiner DK. Advances in understanding the mechanisms and management of persistent pain in older adults. Br J Anaesth 2008;101:111–20.
[43] Creswell JD, Way BM, Eisenberger NI, Lieberman MD. Neural correlates of dispositional mindfulness during affect labeling. Psychosom Med 2007;69:560–5.
[44] Brown KW, Ryan RM, Creswell JD. Mindfulness: theoretical foundations and evidence for its salutary effects. Psychol Inquiry 2007;18:211–37.
[45] Ditto B, Eclache M, Goldman N. Short-term autonomic and cardiovascular effects of mindfulness body scan meditation. Ann Behav Med 2006;32:227–34.
[46] Garland E, Gaylord S, Park J. The role of mindfulness in positive reappraisal. Explore (NY) 2009;5:37–44.
[47] Linehan MM. Skills training manual for treating borderline personality disorder. New York (NY): Guilford Press, 1993.
[48] Melzack R. The McGill Pain Questionnaire: from description to measurement. Anesthesiology 2005;103:199–202.