

Does self-report mindfulness mediate the effect of Mindfulness-Based Stress Reduction (MBSR) on spirituality and posttraumatic growth in cancer patients?

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(Received 25 February 2013; accepted 3 May 2014)

This longitudinal waitlist-controlled study evaluated the effects of Mindfulness-Based Stress Reduction (MBSR) on spirituality, posttraumatic growth (PTG), and mindfulness in cancer patients. The study also assessed whether increased mindfulness mediated the effects of MBSR on spirituality and PTG. Patients were either registered for immediate participation in MBSR ($n = 135$), or were naturally waiting for the next program ($n = 76$). Participants completed questionnaires pre-, mid-, and post-MBSR, or waiting period. Hierarchical linear modeling (HLM) was employed to assess changes over time as a function of condition (MBSR vs. waitlist). Mediation was tested using linear regression and bootstrapping. MBSR participants demonstrated increased spirituality, PTG, and mindfulness, relative to controls. Change in all mindfulness facets mediated the effect of MBSR on spirituality and PTG. The development of mindfulness skills through MBSR may facilitate a sense of meaning, peacefulness, connectedness, and personal growth in cancer patients. This investigation contributes to an emerging focus on determining 'how' mindfulness-based interventions work.

Keywords: mindfulness; meditation; posttraumatic growth; spirituality; cancer

Introduction

Receiving a cancer diagnosis and treatment often has prolonged physical and psychosocial implications (Adler, Page, & National Institute of Medicine, 2008). Many patients report high levels of anxiety, depression, fatigue, pain, and sleep difficulties following completion of primary cancer treatments (Carlson et al., 2004). Despite diminished physical health and functioning, cancer patients often indicate positive psychosocial change, including increased spirituality, appreciation of life, and more positive perceptions of significant others (e.g. Cordova, Cunningham, Carlson, & Andrykowski, 2001).

Two notable positive outcomes often experienced by cancer patients include increased spirituality and post-traumatic growth (PTG). In the context of coping with a chronic and/or life-threatening illness, spirituality is defined as having a sense of meaning and purpose in life, a sense of community and connection with others, a sense of strength and comfort from one's faith, and an overall sense of harmony and peace (Brady, Peterman, Fitchett, Mo, & Cella, 1999; Peterman, Fitchett, Brady, Hernandez, & Cella, 2002). PTG, a term sometimes used interchangeably with the term 'benefit-finding,' is defined as the collective positive benefits or implications, of the

cancer diagnosis and experience, and the life changes that follow (Lechner & Antoni, 2004; Linley & Joseph, 2004). Development of PTG and spirituality may contribute to improvements in long-term psychosocial adjustment (Carver & Antoni, 2004; Henoeh & Danielson, 2009; Morrill et al., 2008; Tallman, Altmaier, & Garcia, 2007). Moreover, psychosocial interventions are shown to enhance cancer patients' sense of growth through the experience of trauma by enhancing meaning, connection, purpose, and peace which may facilitate adjustment to the disease and its consequences.

Mindfulness, MBSR, and enhanced positive outcomes of the cancer experience

In the contemporary psychological literature, the term 'mindfulness' refers to mindful awareness as a way of being – a knowing and experiencing of feelings, thoughts, and perceptions as they arise and pass away each moment (Shapiro & Carlson, 2009). It is a way of relating to all experiences in an open, receptive way, without judging experiences as good or bad (grasping at them or pushing them away) (Bishop et al., 2004). Mindfulness meditation, or mindfulness practice, consists

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of intentionally engaging in the task of focusing and sustaining attention to present-moment experience with acceptance (Shapiro & Carlson, 2009). Mindfulness practice consists of two common styles of meditation: 'concentrative' and 'receptive' meditation (Jha, Krompinger, & Baime, 2007; Lutz, Slagter, Dunne, & Davidson, 2008). These are often combined in a single mindfulness practice session or over the course of a practitioner's training (Lutz et al., 2008). Concentrative meditation involves intentionally focusing attention on a chosen object (e.g. the sensations of breathing) in a sustained way. Receptive or 'open awareness' meditation involves monitoring the content of experience (e.g. sensations, emotions, thoughts, sounds, etc.) in a nonreactive and nonjudgmental way, from moment to moment, with the goal being to recognize the nature of emotional and cognitive patterns. Both styles are taught within the secular interventions that draw on Buddhist practices, such as Mindfulness-Based Stress Reduction (MBSR).

Mindfulness meditation is increasingly being applied as a stress reduction tool in medical and psychological treatment settings, including cancer care (Carlson & Speca, 2010). MBSR is a group intervention consisting of mindfulness meditation and gentle yoga that is designed to have applications for stress, pain, and illness (Kabat-Zinn, 1990). The foundational premise of the MBSR program is that the techniques practiced (i.e. mindfulness meditation) cultivate mindfulness as a quality of consciousness (Kabat-Zinn, 1990). Although the MBSR program provides instruction in mindfulness in a secular manner, mindfulness has its roots in Buddhism and is a practice that has long been associated with spiritual growth (Wallace & Shapiro, 2006).

In cancer settings, participation in MBSR is associated with positive outcomes including increased spirituality, PTG, self-compassion, and positive states of mind (Birnie, Garland, & Carlson, 2010; Birnie, Speca, & Carlson, 2010; Bränström, Kvillemo, Brandberg, & Moskowitz, 2010; Carmody & Baer, 2008; Garland, Carlson, Cook, Lansdell, & Speca, 2007; Kvillemo & Bränström, 2010; Lengacher et al., 2009; Mackenzie, Carlson, Munoz, & Speca, 2007). A recent randomized study in early stage breast cancer patients was the first to compare MBSR to an active (dietary education) condition in addition to a usual care condition. MBSR was uniquely effective in promoting meaningfulness and spirituality, among other beneficial outcomes. Changes in spirituality were among those maintained at two-year follow-up (Henderson et al., 2012). Learning to pay attention in the present, with an attitude of acceptance and 'letting go,' may enhance spirituality and growth when coping with cancer-related trauma and loss.

Mindfulness as a mediator of spirituality and PTG

Although it is plausible that increased mindfulness through MBSR may account for enhanced positive outcomes of the cancer experience, this hypothesis remains untested. In a sample of patients with stress-related concerns who participated in MBSR, improvements in self-reported mindfulness were associated with increased spirituality (Carmody, Reed, Kristeller, & Merriam, 2008). Directing attention toward what may be perceived 'here and now' may reduce preoccupation with daily worries and enhance satisfaction with and gratitude for what is occurring in the present, resulting in a deeper sense of spiritual well-being (Carmody et al., 2008). By attending to all aspects of present-moment experience with acceptance, patients may more clearly see what is most important in their lives. Understanding what is most important may enable patients to choose behaviors that are congruent with their values, perhaps creating a more satisfying life experience.

Mindfulness meditation practice consists of attending to, rather than avoiding unpleasant internal experiences. Studies have shown that active processing (vs. avoidance) of highly challenging life circumstances can facilitate PTG (e.g. Tedeschi & Calhoun, 2004). It follows that practicing mindfulness may enable more active processing of the cancer experience. For example, noticing the thought 'I might die from this' and the associated feelings of fear and grief may lead to a deeper understanding and acceptance of these thoughts and feelings. In a review of both cross-sectional and prospective longitudinal studies of cancer patients, when PTG occurred, it was associated with positive and active coping strategies including reframing one's cancer experience in a positive way and accepting one's current situation (Stanton et al., 2005).

In addition to creating change on a cognitive and behavioral level resulting in enhanced PTG and spirituality, MBSR may lead to participants finding meaning through experiential insight and self-transcendence. Self-transcendence is a sense of relatedness to dimensions within and beyond the self, and is intrinsic to definitions of spirituality (Garland, 2007; Reed, 1992). Practicing mindfulness meditation in MBSR may engender experiential insight into the ever-changing, impermanent nature of phenomenal experience: that all perceptual, sensory, emotional, and cognitive experiences are constantly in flux (Grabovac, Lau, & Willett, 2011). From a Buddhist psychology perspective, the nature of reality is such that not only is all experience continually changing, but so is one's experience of self (Kalupahana, 1987, as cited in Garland, 2007). It is in our nature for our bodies to change, to become sick and disabled, and to die; certainly, many cancer patients are actively confronted with this reality of human experience. While clinging to fixed

self-concepts leads to stress, mindfulness may enable an experiential understanding of impermanence, interdependence and the systemic, integrated nature of reality (Garland, 2007; Shapiro & Schwartz, 2000).

In sum, although MBSR is secular in nature and does not explicitly target spirituality or PTG, these outcomes may occur quite naturally as participants engage mindfully with their internal and external experience (Mackenzie et al., 2007). Making space for present-moment experience may lead to a greater sense of gratitude, meaning, and connection with self, others, and a higher power, particularly in the context of a life-threatening illness.

Objectives

This longitudinal waitlist-controlled study sought to: (1) replicate previous research demonstrating a beneficial effect of MBSR on mindfulness and positive outcomes of a cancer experience (spirituality and PTG) and (2) test whether increased mindfulness mediates the effect of MBSR on spirituality and PTG.

Testing mediation represents an important ‘first step’ in determining program mechanisms. Mediation analyses inform the design of fully experimental trials using randomized component-controlled designs to isolate causal mechanisms. Tailoring programs accordingly (i.e. ensuring adequate levels of mediating components and excluding unnecessary components) can render such programs more effective and efficient, allowing benefits to be more accessible to patients (Kazdin, 2006; Kraemer, Wilson, Fairburn, & Agras, 2002; Laurenceau, Hayes, & Feldman, 2007).

Method

MBSR intervention

The MBSR program offered at the Tom Baker Cancer Centre (TBCC) is known as *Mindfulness-Based Cancer Recovery* (MBCR) (Carlson & Speca, 2010). It was modeled on the work of Kabat-Zinn (1990), adapted and standardized to the clinical context of the TBCC. MBSR/MBCR provides an opportunity to become aware of one’s personal responses to stress and to learn and practice techniques that will bring about healthier stress responses. The intervention was provided over the course of eight weekly, 90 min group sessions, as well as one 6 h intensive session on a Saturday between weeks six and seven.

Group sessions were facilitated by two psychologists and a nurse who have been delivering the intervention for over 10 years. Each session included didactic teaching (e.g. ‘What is mindfulness?’), experiential exercises (including mindfulness meditation and gentle Hatha

yoga), and group discussions to facilitate learning and motivate and support effective practice. Supportive interaction between group members was encouraged. Participants were expected to practice the prescribed meditation and yoga techniques daily, for 45 min.

Recruitment and study design

Data collection began in October 2007 and included eight consecutive eight-week MBSR programs spaced four months apart, and eight ‘waiting periods’ between programs. All patients were recruited from those who had signed up and were waiting for an upcoming program. Patients were referred to the program waitlist by medical or psychosocial resources staff, or were self-referred through word-of-mouth or after viewing pamphlets and posters placed around the cancer clinics. Patients were deemed eligible for the study if they met the following inclusion criteria: (1) age 18 years or older, (2) a diagnosis of any type of cancer, at any time in the past, (3) speak and read English sufficiently to complete questionnaires, and (4) had not previously participated in an MBSR group.

To obtain an adequate sample size ($n = 122$ with complete data) (Fritz & MacKinnon, 2007; MacKinnon, Lockwood, & Williams, 2004; Tabachnick & Fidell, 2001), 324 cancer patients were screened for eligibility (refer to flow chart, Figure 2). Participants completed a questionnaire package three times: pre-, mid- (after four weeks), and post- (after eight weeks) MBSR, or waiting period (control group participants). They received a reminder phone call from a research assistant when it was time to fill out and return each questionnaire package. Participants recorded the number of minutes spent in home practice (meditation and yoga) using forms provided, which were collected each week during class. The study was approved by the Conjoint Health Research Ethics Board of the University of Calgary/Alberta Health Services.

Measures

Posttraumatic Growth Inventory (PTGI; Tedeschi & Calhoun, 1996)

The PTGI is a 21-item self-report inventory that measures the individual’s perception of positive changes following a traumatic life experience. Participants are asked to rate the extent to which their views changed as a result of their illness (e.g. [as a result of my cancer diagnosis/treatment/recovery] I changed my priorities about what is important in life). Internal consistency was 0.90 for the normative sample and 0.95 in a sample of cancer patients. Test–retest reliability, measured in the normative sample two months later, was within

acceptable limits (0.71) (Tedeschi & Calhoun, 1996). Internal consistency in the current sample was 0.95.

Functional Assessment of Chronic Illness Therapy-Spiritual Well-Being (FACIT-Sp; Peterman et al., 2002)

FACIT-Sp Subscale was designed to measure spirituality in people with chronic and/or life-threatening illnesses. This scale is comprised of 12 questions and provides an overall measure of spirituality along with two subscales corresponding to one's sense of meaning and/or purpose in life (e.g. My life lacks meaning and purpose) and one's comfort and support from their personal faith (e.g. I receive support from my faith). The FACIT-Sp has been found to be valid and reliable in persons with cancer and HIV (Brady et al., 1999). Overall, Cronbach's alpha was 0.87, 0.81 for the meaning/peace subscale, and 0.88 for the faith subscale. The total score was used in the current study and demonstrated good internal consistency ($\alpha = 0.88$).

Five-Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006)

Baer and colleagues determined that the combined pool of 112 items from five different mindfulness questionnaires contains five clear, interpretable facets of mindfulness: *Observe* refers to the tendency to notice or attend to internal and external experience (e.g. thoughts, emotions, sensations, smells, sights, sounds), *Describe* refers to the tendency to label internal experiences with words, *Act* refers to attending to one's activities of the moment (the opposite of acting on 'automatic pilot' – this scale includes several items from the Mindful Attention Awareness Scale), *Nonjudge* refers to taking a nonevaluative stance towards thoughts and feelings, and *Nonreact* refers to the tendency to allow thoughts and feelings to come and go, without getting caught up in them. In the current sample, the FFMQ facets demonstrated acceptable-to-excellent internal consistency (Cronbach's alphas): Observe (0.78), Describe (0.91), Act (0.88), Nonjudge (0.89), and Nonreact (0.80).

Data analyses

Intervention effects

For all psychological variables, distributions of residuals were found to be normally distributed. Two-level HLM was employed to assess potential changes over time, as a function of condition (MBSR vs. control) for Time 0 (pre), Time 1 (mid), and Time 2 (post) data obtained on measures of mindfulness, spirituality, and PTG. HLM 6 statistical software (Raudenbush, Bryk, & Congdon, 2004) was used to run the hierarchical linear models. Compared with more conventional (e.g. ANOVA)

approaches, HLM procedures (a form of mixed-effects models) provide a more precise characterization of individual growth and allow improved handling of unbalanced designs and missing data (Liu & Gould, 2002; Mallinckrodt, Clark, & David, 2001; Nich & Carroll, 1997). HLM also allows for inclusion of all available data in making estimates. Using an intent-to-treat sample, for each HLM, at Level 1 (unconditional growth model), each participant's scores over time was represented by an individual growth trajectory, and at Level 2 (conditional model) intercepts and slopes as outcomes were modeled with Group (MBSR vs. control, dummy coded as 0.5 and -0.5) added as a predictor. The fixed effect of Group on individual growth rates (i.e. the Group \times Time interaction) was examined to ascertain whether MBSR group participants changed differently over time, relative to controls (Raudenbush & Bryk, 2002).

Effect sizes were computed for each outcome variable based on the recommended formula, $d = \beta_{11}(\text{Time}) / \text{SD}_{\text{raw}}$, which produces effect sizes that are comparable to those for between-groups designs (Feingold, 2009; Raudenbush & Xiao-Feng, 2001). In this formula, β_{11} was the difference between the groups in mean growth rates, Time was a value of '2' as the linear weight for Time differed by one unit between waves (i.e. 0-1 and 1-2), and SD_{raw} was the standard deviation of raw scores at baseline (Time 0).

Testing each mindfulness facet as a mediator

For mediation analyses, residualized pre-post change scores (e.g. the difference between the observed score at Time 2 and the predicted score at Time 2, where the Time 0 measure is used to predict Time 2) were used in lieu of raw change scores (MacKinnon, 2008).

As per current conventions and recommendations for testing mediation, causal steps (Baron and Kenny) linear regression analyses were run, followed by nonparametric bootstrapping to test the statistical significance of each mediated effect (Baron & Kenny, 1986; Fritz & MacKinnon, 2007; Kraemer et al., 2002; MacKinnon, Fairchild, & Fritz, 2007; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; MacKinnon et al., 2004). In causal steps analyses, a series of linear regressions tested whether the independent variable was associated with change in the mediator, the latter of which was associated with change in the outcome, above and beyond the direct effect of independent variable on outcome (Baron & Kenny, 1986). With the causal steps approach, mediation is deemed to be present when the following four steps are satisfied: (1) a significant relationship of the independent variable (IV) to the dependent variable (DV), (2) a significant relation of the IV to the hypothesized mediating variable, (3) the mediating variable is significantly related to the DV when both the

IV and mediating variable are predictors of the DV, and (4) the coefficient relating the IV to the DV (from Step 1) is larger (in absolute value) than the coefficient relating the IV to the DV in the regression model, with both the IV and the mediating variable predicting the DV (from Step 3) (Baron & Kenny, 1986).

Tests of the indirect effect (bootstrapping) were used to supplement the causal steps approach, with interpretations based on results of tests of the indirect effect (Hayes, 2009). Preacher and Hayes' (2008) SPSS syntax was used to derive bias-corrected and accelerated 95% confidence intervals (CIs) for indirect effects. Five thousand repeated random samples were taken from the original data to compute the indirect effects. Mediation is said to occur if the derived CI does not contain zero (Preacher & Hayes, 2004).

Following recent recommendations for reporting effect sizes in mediation analyses, two effect sizes were computed to index the magnitude of each indirect effect (Preacher & Kelley, 2011; Shrout & Bolger, 2002):

- (1) effect proportion mediated (R_M): $R_M = \beta_a \beta_b / \beta_c$, and
- (2) standardized indirect effect (ab_s): $ab_s = \beta_a \beta_b$.

where β_a , β_b and β_c are the standardized coefficients from the regressions testing the a , b , and c pathways of the mediation model (Figure 1). R_M is intuitive as it can be interpreted as a proportion in most situations (i.e. the proportion of variance in the DV accounted for by the indirect effect). The ab_s indicates the amount of change in the DV (in standard deviations) for every one standard deviation change in the IV indirectly via the mediator. ab_s can be compared across studies and outcomes, and retains interpretability when the total effect of IV on DV (i.e. path c) is not statistically significant (Preacher & Kelley, 2011).

Associations with adherence

Pearson product-moment correlations were conducted to test associations between (1) the number of MBSR

sessions attended and pre- to post-MBSR residualized change in mindfulness, spirituality, and PTG in MBSR participants who completed the study and (2) minutes of meditation, yoga, and total practice, and pre- to post-intervention residualized change in mindfulness, spirituality, and PTG in MBSR participants who completed the study and returned at least 50% of their meditation logs.

Mediation effects and associations with group attendance were examined using the 'completer' sample, as potential pathways of change may be strongest in this subset of participants. Use of a 'completer' sample also allowed for application of recommended statistical approaches for testing mediation in the context of a controlled intervention study.

Results

Participant flow

Participant flow is documented in Figure 2. One hundred and thirty-five patients were recruited for the MBSR group and 76 patients were recruited for the control group. MBSR group participants were considered to have dropped out if they attended fewer than 50% of the MBSR classes (i.e. <5 out of 9, including the Saturday retreat) and/or did not return all three questionnaire packages. Control group participants were considered to have dropped out if they did not return all three questionnaire packages. Significantly more MBSR group participants ($n = 58$; 43%) than control group participants ($n = 15$; 20%) did not return all three questionnaire packages, $\chi^2(1) = 11.59$, $p < 0.01$. The completer sample (used to test mediation and associations with group attendance) consisted of 75 treatment group participants and 61 controls ($N = 136$). HLMs testing treatment effects were conducted using the entire sample ($N = 211$).

T -tests and chi-square tests revealed several differences between participants who dropped out and those who completed the study, at baseline. Relative to study completers, those who dropped out were younger ($M = 49.31$ vs. $M = 54.66$ years, $t(1209) = 3.45$, $p < 0.01$) and tended to be male (52.4% of men vs. 31.4% of women dropped out; $\chi^2(1) = 6.49$, $p < 0.05$). Relative to

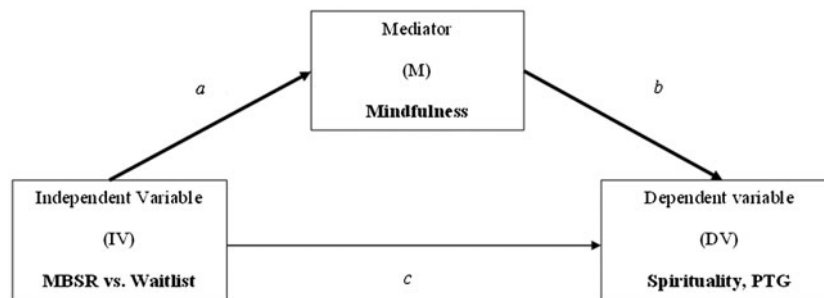
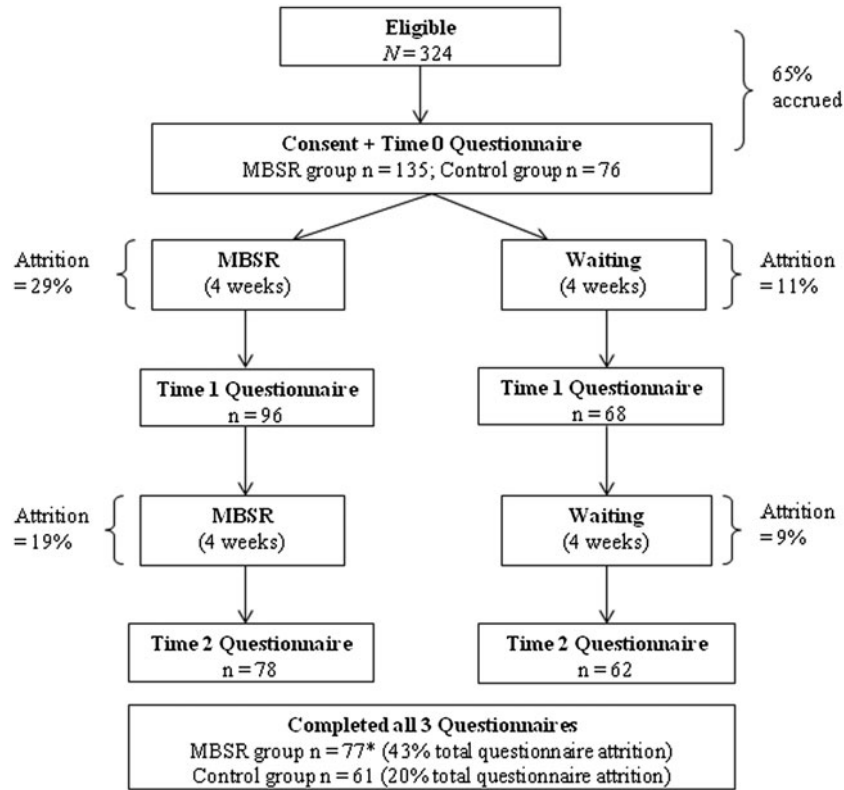


Figure 1. Path diagram representing the proposed mediation model.



* Two MBSR participants who completed all 3 questionnaires attended fewer than 5 MBSR classes, and therefore are considered drop-outs. The final mediation sample: MBSR group $n = 75$ and Control group $n = 61$.

Figure 2. Flow chart of eligibility, accrual, and questionnaire attrition.

completers, dropouts had lower spirituality scores ($t(1207) = -3.30$, $p < 0.01$). No significant differences emerged between dropouts and completers, on any of the other 15 medical, demographic, or psychological variables.

Sample characteristics ($N = 211$)

Participants were mostly female (80.1%), White (92.4%), and married or living common-law (71.1%) (Table 1). They had a mean age of 52.7 years ($SD = 11.0$) and a mean of 15.2 years of education ($SD = 2.0$). A minority of participants (38.4%) were employed more than 20 h/week. Participants had been diagnosed with cancer, a mean of 23.5 months ($SD = 43.0$) prior to study entry. Most had a diagnosis of breast cancer (58.8%; $n = 124$), with other types of cancer including genitourinary ($n = 19$), gastrointestinal ($n = 18$), lymphoma/myeloma ($n = 11$), head/neck ($n = 10$), gynaecological ($n = 9$), lung ($n = 8$), thyroid ($n = 5$), melanoma ($n = 5$), adrenocortical ($n = 1$), and abdominal teratoma adenocarcinoma ($n = 1$). Most participants had received surgery (83.4%) and

chemotherapy (54.0%), and 44.1% had received radiation. The majority (70.1%) were not receiving primary cancer treatments (e.g. surgery, chemotherapy, radiation) during the study period.

Comparability of groups at baseline

In the total sample (MBSR group $n = 135$, control group $n = 76$), t -tests and chi-square tests did not reveal significant baseline (Time 0) group differences on any variable with the exception of PTG. At study outset, MBSR group participants had significantly higher PTG scores relative to controls ($M = 62.57$, $SD = 21.64$ and $M = 55.65$, $SD = 23.25$, respectively), $t(1206) = 2.15$, $p < 0.05$. Among study completers (i.e. the mediation analysis sample: MBSR group $n = 75$ and control group $n = 61$), significantly more MBSR group participants had received a diagnosis of breast cancer (vs. other cancer types) relative to control group participants (70.7% vs. 50.8%, respectively, $\chi^2(1) = 5.61$, $p < 0.05$). MBSR group completers also had higher PTG ($t(133) = 2.05$, $p < 0.05$) relative to controls. Because of this, baseline PTG was

Table 1. Participant characteristics within MBSR and control groups, in intent-to-treat and completer samples.

	Intent-to-treat sample		Completer sample	
	MBSR (<i>n</i> = 135)	Control (<i>n</i> = 76)	MBSR (<i>n</i> = 75)	Control (<i>n</i> = 61)
	<i>M</i> (<i>SD</i>)			
Age at first assessment	52.0 (11.0)	54.0 (10.9)	54.8 (9.9)	54.4 (10.3)
Months since cancer diagnosis	23.8 (37.3)	23.0 (51.8)	25.2 (41.9)	25.3 (57.1)
Years of education	15.2 (1.9)	15.2 (2.2)	15.1 (1.8)	15.6 (1.9)
% female	82.2	76.3	89.3	80.3
% white	93.3	90.8	89.3	90.2
% married/living with a partner/spouse	72.6	68.4	73.3	62.3
% employed 20+ h/week	39.3	36.8	40.0	37.7
% diagnosed with breast cancer	63.0	51.3	70.7	50.8*
% had received surgery	85.9	78.9	88.0	78.7
% had received radiation	41.0	50.7	44.6	56.7
% had received chemotherapy	56.7	50.0	49.3	52.5
% completed primary cancer treatment before first assessment	74.8	61.8	78.7	63.0

Note: *Among study completers, significantly more patients in the MBSR group (vs. control group) had a breast cancer diagnosis ($p < 0.05$).

included as a covariate in mediation analyses. Questionnaire descriptive statistics for study completers (the mediation analysis sample) at each time point are presented in Table 2.

Program adherence and compliance with home practice

In calculating MBSR program adherence, class attendance records were missing for 26 of the MBSR participants who did not return all three questionnaire packages. Of those MBSR participants for whom attendance records were available ($n = 109$), the program attendance rate was 70.1%: participants attended a mean of 6.31 ($SD = 2.41$) out of a possible 9 MBSR classes, including the Saturday retreat. Twenty-two participants (20.2%) attended fewer than five classes. Hence, the total MBSR program dropout rate is estimated to be 20% in the current study.

Table 3 presents program adherence in the samples used to test (a) intervention effects, (b) mediation and associations with program attendance, and (c) associations with home practice.

Intervention effects

MBSR program participants demonstrated greater increases in spirituality (FACIT-Sp), $t(507) = 6.12$, $p < 0.001$, and PTG (PTGI), $t(505) = 2.35$, $p < 0.05$, relative to controls. Compared with the control group, participants in MBSR also showed greater increases in mindfulness as measured by FFMQ facets: Observe, $t(208) = 6.34$, $p < 0.001$, Describe, $t(508) = 4.58$, $p < 0.001$, Act, $t(508) = 3.80$, $p < 0.001$, Nonjudge, $t(208) = 4.37$, $p < 0.001$, and Nonreact, $t(508) = 4.67$, $p < 0.001$. Table 4 presents estimates, standard errors, and effect sizes for HLM analyses testing intervention effects.

Table 2. Means and standard deviations on psychological variables for MBSR ($n = 75$) and control group ($n = 61$) study completers at Time 0 and Time 2, and change from Time 0 to 2.

Variable	MBSR group		Control group		Time 0–2 change ^a	
	Time 0 mean (SD)	Time 2 mean (SD)	Time 0 mean (SD)	Time 2 mean (SD)	MBSR mean (SD)	Control mean (SD)
FACIT-Sp	30.50 (8.62)	35.35 (7.26)	27.89 (9.08)	27.13 (10.71)	4.85 (6.54)	-0.75 (7.03)
PTGI	64.87 (19.25)	72.25 (19.80)	57.13 (24.65)	58.72 (23.58)	7.39 (13.23)	1.58 (13.84)
Observe	25.78 (5.25)	29.53 (4.69)	25.39 (5.45)	25.20 (5.50)	3.75 (4.38)	-0.20 (3.30)
Describe	25.52 (6.64)	28.44 (6.23)	26.95 (6.14)	26.66 (6.10)	2.93 (3.84)	-0.30 (3.44)
Act	26.47 (5.56)	28.76 (4.30)	25.03 (5.72)	24.85 (5.85)	2.29 (4.73)	-0.18 (3.37)
Nonjudge	27.65 (6.07)	29.23 (5.14)	26.56 (6.00)	26.21 (6.34)	3.10 (5.59)	-0.34 (4.24)
Nonreact	19.58 (3.40)	22.63 (3.91)	19.12 (4.41)	19.38 (5.02)	3.05 (3.95)	0.26 (3.28)

^aRaw change scores.

Notes: *M* = mean, *SD* = standard deviation, *n* = sample size. FACT-Sp = Functional Assessment of Chronic Illness Therapy-Spiritual Well-Being; PTGI = Posttraumatic Growth Inventory.

Table 3. Program adherence in intent-to-treat, mediation, and home practice analysis samples.

	Intent-to-treat sample <i>N</i> = 135		Mediation sample (study completers) <i>n</i> = 75		Home practice sample (study completers who returned >50% of logs) <i>n</i> = 53	
	<i>M</i> (SD)	% compliance	<i>M</i> (SD)	% compliance	<i>M</i> (SD)	% compliance
Number of classes attended	6.31 (2.41)*	70.1	7.45 (1.35)	82.8	7.50 (1.41)	83.3
Number of log sheets returned	3.79 (3.43)	47.4	5.75 (3.07)	71.5	7.56 (0.87)	94.5
Meditation (min/day)	9.98 (13.72)	–	16.78 (15.46)	–	22.35 (14.94)	–
Yoga (min/day)	5.75 (8.96)	–	10.52 (12.13)	–	14.07 (12.61)	–
Total home practice (min/day)	15.72 (20.76)	34.9	27.30 (25.32)	60.7	36.43 (24.54)	81.0

Note: *Includes MBSR participants for whom class attendance records were available (*n* = 109).

Table 4. Estimates, standard errors, and effect sizes for HLM analyses testing intervention effects (*N* = 211).

Variable	Baseline effects		Change effects		
	Intercept ^a	Group	Time	Group × Time	ES
FACIT-Sp	27.60 (0.67)	1.18 (1.34)	1.35 (0.29)***	3.22 (0.58)***	0.67
PTGI	58.79 (1.59)	7.24 (3.19)*	2.25 (0.59)***	2.61 (1.78)*	0.23
Observe	25.54 (0.37)	0.46 (0.74)	0.99 (0.16)***	2.05 (0.32)***	0.79
Describe	26.36 (0.46)	−0.32 (0.93)	0.59 (0.15)***	1.39 (0.30)***	0.43
Act	25.32 (0.37)	0.68 (0.74)	0.58 (0.16)**	1.22 (0.32)***	0.45
Nonjudge	26.66 (0.44)	0.20 (0.88)	0.82 (0.21)***	1.84 (0.42)***	0.59
Nonreact	19.39 (0.30)	0.20 (0.60)	0.80 (0.15)***	1.41 (0.30)***	0.67

Notes: FACIT-Sp = Functional Assessment of Chronic Illness Therapy-Spiritual Well-Being scale; PTGI = Posttraumatic Growth Inventory; Est.: change estimate; SE: standard error; ES: effect sizes for Group × Time interactions.

p* < 0.05; *p* < 0.01; ****p* < 0.001.

^aAll intercepts are significantly different from 0 (*p*'s < 0.001).

Mindfulness as a mediator

Spirituality

The effect of Group on FACIT-Sp change was significant ($\beta = 0.45$, $p < 0.001$) (Step 1). The effect of Group on FFMQ-facet change was also significant (coefficients ranging from 0.39 for Describe and Nonreact to 0.50 for Observe, all p 's < 0.001) (Step 2). FFMQ-facet change significantly predicted FACIT-Sp change, controlling for treatment group (coefficients ranging from 0.24 ($p < 0.01$) for Describe to 0.33 ($p < 0.001$) for Observe) (Step 3). For each potential mediator, the coefficient for Group as a predictor of FACIT-Sp change was reduced when the mediator entered the model to values ranging from 0.28 ($p < 0.01$) for Observe, to 0.36 ($p < 0.001$) for Describe (Step 4). Bootstrap analyses confirmed that the indirect effects of Group through Observe (1.16, 3.96), Describe (0.36, 2.74), Act (0.61, 3.03), Nonjudge (0.59, 3.07), and Nonreact (0.72, 3.19) change (separately) on spirituality change were statistically significant as the 95% CIs did not contain 0. The direction of the *a* and *b* paths are consistent with the interpretation that MBSR participation leads to increased mindfulness, which in

turn leads to increased spirituality. Results of causal steps and bootstrapping analyses, and effect sizes are presented in Table 5.

PTG

The effect of Group on PTGI change was significant ($\beta = 0.28$, $p < 0.01$) (Step 1). As reported above, the effect of Group on FFMQ-facet change was also significant (Step 2). FFMQ-facet change significantly predicted PTGI change, with treatment group in the model (coefficients ranging from 0.22 ($p < 0.05$) for Nonjudge to 0.37 ($p < 0.001$) for Observe) (Step 3). For each potential mediator, the coefficient for Group as a predictor of PTGI change was reduced when the mediator entered the model to values ranging from 0.10 (n.s.) for Observe, to 0.20 ($p < 0.05$) for Describe and Nonreact (Step 4). The 95% CIs from the bootstrap analyses confirmed that the indirect effects of Group through Observe (2.50, 7.62), Describe (0.54, 4.77), Act (1.57, 6.64), Nonjudge (0.65, 5.17), and Nonreact (2.02, 6.97) change (separately) on PTG change were statistically significant as they did not

Table 5. Results of mediation analyses testing mindfulness variables as individual mediators of the impact of Group on spirituality.

Step	Causal steps linear regressions				Bootstrapping		Effect size		
	Independent variable (+ covariate) ^a	Dependent variable	Standardized coefficient	p-value	Point estimate	CI	P_M	ab_s	
1	Group	FACIT-Sp	0.44	<0.001					
2	Group	Observe	0.50	<0.001					
		Describe	0.39	<0.001					
		Act	0.38	<0.001					
		Nonjudge	0.39	<0.001					
		Nonreact	0.36	<0.001					
		FACIT-Sp	0.34	<0.001					
3	Observe + Group	Describe + Group	0.24	<0.01					
		Act + Group	0.29	<0.001					
		Nonjudge + Group	0.28	<0.01					
		Nonreact + Group	0.20	<0.05					
		Group + Observe	FACIT-Sp	0.28	<0.01	2.35	(1.18, 4.03)	0.39	0.17
		Group + Describe		0.35	<0.001	1.30	(0.36, 2.71)	0.21	0.09
4	Group + Act	Group + Nonjudge	0.34	<0.001	1.56	(0.57, 2.91)	0.25	0.11	
		Group + Nonreact	0.37	<0.001	1.02	(0.33, 1.97)	0.16	0.07	

^aIn each causal steps analysis, for Steps 3 and 4, a single regression was run with Group and the respective mindfulness variable as predictors. Notes: P_M =proportion of indirect effect to total effect; ab_s =standardized indirect effect. FACT-Sp=Functional Assessment of Chronic Illness Therapy-Spiritual Well-Being; PTGI=Posttraumatic Growth Inventory.

contain 0. The direction of the *a* and *b* paths are consistent with the interpretation that MBSR participation leads to increased mindfulness, which in turn leads to increased PTG. Results of causal steps and bootstrapping analyses, and effect sizes are presented in Table 6.

Associations with adherence

Among the 75 MBSR participants who completed the study, number of sessions attended was not significantly

correlated with pre- to post-program change in PTG or spirituality, although a trend toward significance was noted for spirituality, $r=0.22$, $p=0.06$. No other significant correlations with program attendance were observed. Seventy-one percent of study completers in the MBSR group ($n=53$) returned at least five out of eight meditation logs and were included in analyses testing associations with amount of home practice. No statistically significant associations were observed between number of minutes of home meditation, yoga, or total

Table 6. Results of mediation analyses testing mindfulness variables as individual mediators of the impact of Group on PTG.

Step	Causal steps linear regressions				Bootstrapping		Effect size		
	Independent variable (+ covariate) ^a	Dependent variable	Standardized coefficient	p-value	Point estimate	CI	P_M	ab_s	
1	Group	PTGI	0.27	<0.01					
2	Group	Observe	0.50	<0.001					
		Describe	0.39	<0.001					
		Act	0.38	<0.001					
		Nonjudge	0.39	<0.001					
		Nonreact	0.36	<0.001					
		PTGI	0.37	<0.001					
3	Observe + Group	Describe + Group	0.23	<0.05					
		Act + Group	0.35	<0.001					
		Nonjudge + Group	0.23	<0.05					
		Nonreact + Group	0.22	<0.05					
		Group + Observe	PTGI	0.09	n.s.	4.86	(2.55, 7.79)	0.69	0.19
		Group + Describe		0.18	<0.05	2.33	(0.72, 5.14)	0.33	0.09
4	Group + Act	Group + Nonjudge	0.18	<0.05	3.47	(1.60, 6.22)	0.49	0.13	
		Group + Nonreact	0.19	<0.05	2.38	(0.49, 4.78)	0.33	0.09	
		Group + Nonreact		0.19	<0.05	2.09	(0.62, 4.24)	0.29	0.08

^aIn each causal steps analysis, for Steps 3 and 4, a single regression was run with Group and the respective mindfulness variable as predictors. Notes: P_M =proportion of indirect effect to total effect; ab_s =standardized indirect effect. FACT-Sp=Functional Assessment of Chronic Illness Therapy-Spiritual Well-Being; PTGI=Posttraumatic Growth Inventory.

practice and pre- to post-MBSR change in mindfulness, spirituality, or PTG.

Discussion

This is the first study to evaluate mindfulness as a mediator of positive outcomes during MBSR. Increased mindfulness (all FFMQ facets) mediated the association between MBSR participation, and enhanced spirituality and PTG in cancer patients. For both spirituality and PTG, attending to present-moment experience (Observe) was the strongest mediator of the effect of MBSR participation. The Observe mindfulness facet includes noticing and attending to internal and external experiences, such as sensations, cognitions, emotions, sights, sounds, and smells (e.g. 'I pay attention to sensations, such as the wind in my hair or sun on my face.'). An awareness of subtleties and the temporariness of each moment may contribute to feelings of synchronicity with one's environment, and a deeper sense of meaning and appreciation of life's richness. Moreover, learning to observe the rise and fall of thoughts and emotions rather than identifying with them may facilitate an overall feeling of calmness, harmony, and peace, which are core components of spirituality (Brady et al., 1999; Peterman et al., 2002).

Increased mindfulness through MBSR may facilitate PTG specifically, by reducing avoidance of unpleasant thoughts and images, emotions, and body sensations. The psychological trauma literature has shown that traumatic experiences, such as being diagnosed with a terminal illness, are often accompanied by avoidance of negative thoughts, emotions, and images related to the event (Honig, Grace, Lindy, Newman, & Titchener, 1999; Schwabish, 2011). Avoidance patterns limit processing of the traumatic experience which maintains trauma-related symptoms and negative schemas about self, others, the world, and the future (e.g. I am helpless, my future is bleak, the world is against me) (e.g. Gallowicis, Silverman, & Francek, 2000). Moreover, PTG is said to depend on the reconstruction of schemas about self and the world (Tedeschi & Calhoun, 2004). It follows that mindfulness of what is occurring, even when emotions are painful, may enhance processing of the cancer experience, integrate current circumstances with previous notions of self and the world, permit disengagement from previous goals that are no longer adaptive, and facilitate the formation of new life goals based on current realities (Brown, Ryan, & Creswell, 2007; Follette, Palm, & Pearson, 2006). In addition, MBSR may enhance feelings of gratitude for the 'small things,' which may help put the larger trauma into perspective.

In sum, developing mindfulness through the MBSR program may facilitate a greater sense of inner peace, calm, connectedness, meaning, and faith in a higher power, in cancer patients. Enhanced mindfulness through

the program may also increase participants' tendency to perceive benefits of their cancer experience.

Replication of intervention effects

In the current study, MBSR participants showed enhanced spirituality and PTG relative to a waitlist control group, with moderate (0.67) and small (0.23) effect sizes, respectively. Results are consistent with findings from a recent randomized controlled trial using an active control group, showing a beneficial effect of MBSR on spirituality and meaningfulness in early stage breast cancer patients (Henderson et al., 2012). Enhancing spirituality and PTG may benefit cancer patients given that higher levels of these positive outcomes are associated with lower levels of distress, and greater quality of life and well-being (Carver & Antoni, 2004; Lechner, Carver, Antoni, Weaver, & Phillips, 2006; Lissoni et al., 2008; Morrill et al., 2008). In our study, the small effect of MBSR on PTG may be explained by the fact that baseline PTG scores were already quite high (i.e. were comparable to those found in women 5 to 15 years following breast cancer diagnosis) (Cordova et al., 2001; Lelorain, Bonnaud-Antignac, & Florin, 2010).

Consistent with the objectives of MBSR (Kabat-Zinn, 1990), program participants demonstrated increased mindfulness relative to controls on all five of the facets of the FFMQ. In the current study, the effect sizes for changes in mindfulness were largest for Observe (0.79) and smallest for Describe (0.43), and are comparable to effect sizes found in previous MBSR studies with cancer patients (Bränström et al., 2010; Campbell, Labelle, Bacon, Faris, & Carlson, 2011; Labelle, Campbell, & Carlson, 2010). In sum, results replicate research showing a favorable impact of MBSR in terms of enhancing mindfulness, spirituality, and PTG in cancer patients.

Regarding generalizability of findings, the participants in this study represented a typical cross-section of cancer survivors. The most prevalent cancers in general were also the most common in our sample (breast, prostate, colorectal) with the exception of lung cancer; these patients have a lower survival rate and are likely under-represented. The treatments received were also standard; most had surgery and about half had chemotherapy and/or radiation therapy, suggesting a range of disease severities. As with many psychosocial oncology interventions, relative to a general oncology setting, the age of our sample is somewhat younger, more women are represented, and the sample is quite highly educated. As this program is an ongoing clinical service, all patients were eligible to participate, and generalizability is likely adequate, with the above noted exceptions. Participants also likely had adequate functional status, to be able to travel to MBSR groups and participate in the study.

Associations with adherence/compliance

Previous randomized controlled trials of MBSR in cancer patients found that those who attended more sessions and meditated more at home had better outcomes than those who did not (Hoffman et al., 2012; Lengacher et al., 2009; Speca, Carlson, Goodey, & Angen, 2000). However, our analyses of associations between program adherence/compliance and change in mindfulness, spirituality, or PTG did not reveal any significant associations. This null finding is likely not attributable to low amounts of practice given that the analysis included study completers who returned at least 50% of their meditation logs ($n = 53$); they practiced at home for a mean of 36.43 min per day ($SD = 24.54$), hence compliance with home practice in this subgroup of participants was 81%. Overall, low compliance with home practice and returning log sheets in this study may be attributed to the method used for tracking home practice. Participants handed in completed log sheets to the instructors each week when they attended the group. Simply forgetting, or feelings of embarrassment or guilt after not having practiced as recommended may have resulted in fewer log sheets being turned in, or inaccurate estimations of practice time (Carmody & Baer, 2008). A challenge put forth to mindfulness researchers is to develop ways to reliably assess the amount, form, and quality of mindfulness practice.

Contradictory findings in the literature regarding the importance of session attendance and home practice (Carmody & Baer, 2008, 2009; Vettese, Toneatto, Stea, Nguyen, & Wang, 2009) may reflect the fact that most studies evaluate associations with amount of class time and mindfulness practice as a secondary analysis. Experimental paradigms are required to systematically evaluate the dose–response relationship between class time, meditation practice, and change in mediator and outcome variables. For example, home practice may be assigned in one arm of a randomized controlled trial and interventions of varying lengths may be compared (Carmody & Baer, 2009; Vettese et al., 2009). It is plausible that MBSR creates a shift in perspective and world view (e.g. kinder attitudes towards oneself) that is enough to increase self-reported mindfulness and improve outcomes for some participants.

Additional study limitations and directions for future research

Several other methodological limitations and related future directions for research should be given consideration. In the current study, participants were not randomized to MBSR and control groups; we used the naturally occurring waitlist that forms once a program is already underway. It follows that factors other than the

intervention itself may have contributed to change in mediator and outcome variables, including pre-existing group differences and regression towards the mean. We attempted to mitigate baseline group differences in PTG by using HLM (an approach that accounts for group differences at baseline) to test intervention effects, and by including baseline PTG as a covariate in mediation analyses. Randomized, component-controlled or ‘dismantling’ studies isolating program components will permit stronger conclusions regarding mechanisms of action. Future research should also consider whether individual characteristics, such as patient expectancies, amount of time since cancer diagnosis, distress level, age, gender, social support, previous experience with meditation and yoga, or interest in spirituality/alternative therapies, moderate the impact of MBSR on positive outcomes. In addition, studies that include follow-up assessments will permit conclusions regarding the long-term effects of the intervention.

Due to limited knowledge of the timing and sequence of changes during MBSR, mediation was tested using change from pre- to post-MBSR (and waiting period). Future studies should examine and incorporate the timing and sequence of change through MBSR (e.g. weekly measurements) relative to comparison groups, strengthening conclusions regarding mechanisms of action (Baer, 2011). In the current study, mediation was tested in a direction consistent with current theory, that increased mindfulness through MBSR leads to increased spirituality and PTG. It is plausible that mediation may occur in the inverse direction. For example, MBSR may increase participants’ sense of meaning and purpose, which in turn may motivate mindfulness practice. Future research should be designed and powered to test plausible alternative models, including simultaneous or reciprocal effects, using structural equation modeling. Mediation analyses cannot establish definitive causal links. However, they provide evidence for a particular mediation pattern and offer valuable information for the design of fully experimental studies of causal processes (Shrout & Bolger, 2002).

Mediation analyses may also reflect processes that are unique to the subset of patients who completed the MBSR program and/or returned all three questionnaires. Although the MBSR program dropout rate in the current study (~ 20%) is comparable to that observed in previous research (Campbell et al., 2011; Speca et al., 2000), the overall study dropout rate (35.6%) was relatively high. In addition, significantly more participants dropped out of the MBSR condition than the control condition (43% vs. 20%, respectively), potentially influencing mediation results. Completing questionnaires may have seemed less of a burden for waitlist control participants who were anticipating starting MBSR but were not yet engaged in this relatively time-intensive program.

Conclusions

This waitlist-controlled study demonstrated a beneficial effect of MBSR on spirituality, PTG, and suggests that increased mindfulness may be a pathway through which the program enhances these positive outcomes for cancer patients. The investigation contributes to an emerging focus on determining ‘how’ mindfulness-based interventions work in cancer and other populations: increased mindfulness through the MBSR program may facilitate PTG and a greater sense of inner peace, calm, connectedness, meaning, and faith in a higher power in cancer patients. Testing this mediation model further in a rigorous manner will inform our understanding of mindfulness-based interventions and may lead to program modifications that will maximize the effectiveness of MBSR in oncology and other settings.

Acknowledgements

This research is funded by a Mind and Life Francisco J. Varela Research Award and Alberta Innovates Health Solutions. Dr Linda E. Carlson holds the Enbridge Research Chair in Psychosocial Oncology, co-funded by the Alberta Cancer Foundation and the Canadian Cancer Society Alberta/NWT Division. She is also an Alberta Innovates-Health Solutions Health Scholar.

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