



Testing psychosocial mediators of a mind–body resiliency intervention for cancer survivors

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Abstract

Purpose Group-based mind–body interventions such as the Stress Management and Resiliency Training-Relaxation Response Resiliency Program (SMART-3RP) hold promise for enhancing resiliency among cancer survivors. Mechanisms underlying improvements in psychological outcomes are theoretically established but remain unexamined empirically.

Methods Adult cancer survivors ($n = 105$) participating in the SMART-3RP completed surveys of resiliency and five hypothesized mediators: coping (ability to relax physical tension and assertive social support-seeking), mindfulness, positive affect, and worry. Pre-post intervention changes were assessed using repeated-measures t -tests. Bivariate correlations between change scores and a more conservative within-person parallel mediation model tested covariance between resiliency and mediators.

Results Participants experienced moderate to large improvements in all patient-reported outcomes ($ds = 1.01$ – 0.46). Increased resiliency was significantly associated with increases in mindfulness, positive affect, and assertive social support-seeking ($rs = 0.36$ – 0.50); smaller associations with increased relaxation and decreased worry were not significant. Mindfulness and positive affect explained the largest proportion of variance in resiliency increase in the full multivariate model.

Conclusions Cancer survivors completing the SMART-3RP had increased resiliency, which was associated with improvements in mindfulness, positive affect, and the ability to assertively seek social support. Enhancing mindfulness and positive affect were critical components for enhancing resiliency. Implications for resiliency interventions with cancer survivors are discussed.

Keywords Cancer · Mind–body therapies · Neoplasms · Relaxation · Resiliency · Survivorship

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The transition from the initial intensive phase of cancer diagnosis and treatment to posttreatment survivorship encompasses many stressors, including change to identity and close relationships, worries about recurrence, adjustment to treatment side effects, and new routines for self-management [1–5]. Due to these challenges, the Centers for Disease Prevention and Control, National Cancer Institute, and Institute of Medicine (IOM) have recognized survivorship as a unique phase of treatment requiring intervention to enhance quality of life and health-promoting behaviors [3, 6, 7]. For the purposes of the present work, we define cancer survivorship as the period of care beginning immediately following completion of initial treatment during which individuals often experience unmet need for supportive services [3, 8].

Mind–body interventions are uniquely positioned to mitigate the deleterious effects of stress exposure on survivors' psychological distress and resiliency, defined here as one's

ability to enjoy positive experiences following stressful experiences [9]. Recent literature suggests that integrative treatment approaches such as mindfulness-based cognitive-behavioral therapy (CBT), mind–body multimodal resiliency treatments, and meditation, are well-received and feasible to implement as part of survivorship programming [4, 10, 11]. One model for mind–body intervention in cancer survivorship is the SMART-3RP, an 8-session group-based program that incorporates multiple aspects of CBT, meditation, relaxation practice, and positive psychology strategies to enhance participants' overall resiliency [9, 12]. The SMART-3RP has demonstrated preliminary acceptability and efficacy for resiliency, relaxation, positive affect, and general stress reduction among adult survivors of lymphoma [4] and other diverse cancers [13], with promising findings also reported among related behavioral medicine samples, such as adults with clinical precursors to multiple myeloma [14] and chronic tumor suppressor syndromes [15], individuals living with chronic pain [16], and individuals with heart disease [17].

As highlighted in a recent framework paper of the SMART-3RP, key mediators of mind–body intervention's effects on resiliency across stressed samples may include enhancing coping ability, adopting a mindful stance toward stress, increasing engagement with positive emotion, assertive social support-seeking, and reducing worry [9]. Building upon this framework, there is a need to optimize [18] mind–body interventions such as the SMART-3RP to most efficiently promote resiliency in cancer survivorship and understand treatment mechanisms or “active ingredients” of mind–body programs [19, 20].

First, the ability to effectively relax physical tension is a key resource for cancer survivors, given the deleterious impact of uncontrolled physical pain on psychological well-being in cancer care [3, 6]. Survivors who are adept at eliciting the body's relaxation response may enjoy greater positive emotion in the context of painful treatment side effects and increased monitoring of physical symptoms [21, 22]. Second, mindfulness has been linked to lower stress appraisals, self-blame, and behavioral disengagement from stress, as well as greater acceptance of stressful experiences [23–27]. Third, positive affect associates with self-reported resiliency and engagement with health-promoting behaviors [9, 28]. Fourth, decreases in engagement with healthcare providers and other caregivers may contribute to isolation and depressed mood, whereas assertive social-support seeking may increase resiliency [29]. Social support has also been positively linked to engagement with positive health behaviors in cancer survivorship [30]. Finally, worry is a common sequela of the transition to cancer survivorship that interferes with individuals' ability to experience positive affect and participate fully in daily experiences that promote resiliency [31].

Although the SMART-3RP treatment model specifically targets each of these five mediators [9, 12], no existing studies have empirically tested a parallel mediation model through which changes in these domains operate in parallel to drive resilient outcomes. Therefore, the present study aims to (1) establish the efficacy of a group-based mind–body intervention for adult cancer survivors participating in a clinical program with greater heterogeneity than in previous randomized controlled trials [4, 13–17] by measuring the strength of pre-post change in resiliency and five key psychosocial mediators over the course of intervention; (2) examine bivariate associations between total scores for resiliency and treatment mediators as well as longitudinal change in resiliency and mediators; (3) test a full parallel mediation model of indirect paths linking intervention participation to improvements in resiliency via improvements in five key mediators. We hypothesized improvements in resiliency and all mediators and bivariate associations between resiliency and study mediators.

Method

Procedure

Adult cancer survivors were either self- or provider referred to the Massachusetts General Hospital (MGH) Cancer Center's SMART-3RP [12]. Patients were made aware of the SMART-3RP through flyers placed in relevant clinics, online information links hosted by the Benson-Henry Institute for Mind Body Medicine and the MGH Cancer Center, and discussions with their providers. Providers received information about the SMART-3RP through inter-clinician recruitment emails and in-service presentations within the MGH system. MGH patients who spoke English and had completed initial cancer treatment were eligible. Participants provided informed consent to complete optional online surveys via REDCap as part of the clinical program. Study procedures were approved by the MGH IRB (protocol #2011P001081).

Briefly, the SMART-3RP is an 8-week group program delivered by a licensed mental health provider (e.g., psychologist, psychiatrist). In line with space and billing requirements, groups typically include 6–8 participants (range = 3–10). The 8-week program may also be preceded by an initial intake session that is otherwise combined with session one. Although the program was initially designed to be delivered in person, services were transitioned to telehealth in March 2020 at the start of the COVID-19 pandemic. Over the course of 8 weeks of core session content, participants learn and practice various stress-coping skills and assertive strategies grounded in three essential program components: relaxation- response (RR)-eliciting mind–body

techniques (e.g., meditation and breath awareness), CBT (e.g., restructuring of negative thoughts and behaviors), and positive psychology (e.g., shifting of focus to positive experiences). Daily practice of these strategies is expected to result in the promotion of psychological resiliency in the context of chronic stress (e.g., cancer treatment) [9].

Participants

Analyses for the present study utilize data from an ongoing repository of clinical participants who provided consent to participate in an optional research study; as such, no a priori power analysis was performed. One-hundred and five survivors who participated in the SMART-3RP group program between January 2017 and June 2021 and completed pre- and post-program surveys were included in the present study ($n = 192$ with data at any time point). Identifying data needed to access cancer information and attendance were available for 104 participants (99.0%). Percentages reported below are based on the number of participants with complete data on each variable. Most participants were female ($n = 92$; 90.2%). The average participant age was 58.31 (SD = 11.44). A minority of participants endorsed non-White and/or Hispanic ethnicity ($n = 12$, 11.8%). Patients in the present sample completed treatment an average of 1.64 years prior to program start (SD = 2.53, median = 0.77) and average time since primary diagnosis was 3.20 years (SD = 4.31, median = 1.78). Most (82.7%, $n = 86$) participants were treated with curative intent for their primary cancer. The most common primary cancer type was breast (64.4%, $n = 67$), with smaller numbers of participants reporting primary blood/lymph (12.5%, $n = 13$), gynecological (7.7%, $n = 8$), or other cancer types (15.4% $n = 16$).

Measures

Mindfulness The 12-item Cognitive and Affective Mindfulness Scale-Revised (CAMS-R) measured trait mindfulness [32]. Self-report items reflecting one's ability to be present in everyday life (e.g., "I am able to focus on the present moment") were scored on a 4-point scale ranging from 1 ("rarely/not at all") to 4 ("almost always"). Total scores were calculated as the sum of all items (possible range = 12–48). The CAMS-R has demonstrated good reliability and validity in previous studies of cancer survivors [33]. Omega reliability was acceptable (0.73 at baseline, 0.76 at follow-up).

Positive affect The Positive and Negative Affect Schedule (PANAS; positive scale) measured positive affect using 10 items (e.g., I generally feel "excited"), scored from 1 ("slightly or not at all") to 5 ("extremely") [34]. Total scores were calculated as the sum of all items (possible range = 10–50). Among related populations, such as

individuals with advanced stage cancer, the PANAS has demonstrated good psychometric properties [35]. Omega reliability was good (0.89 at baseline, 0.89 at follow-up).

Coping abilities Assertive social support-seeking was measured using the 3-item assertiveness subscale of the Measure of Current Status-Part A (MOCS-A) [36]. Items reflecting assertive social support-seeking, such as "I can clearly express my needs to other people who are important to me," were scored from 0 ("I cannot do this at all") to 4 ("I can do this extremely well"). This measure has demonstrated sensitivity to change in previous iterations of the SMART-3RP [37], as well as other mind-body interventions specifically for cancer survivors [22]. Total assertive social support-seeking scores were calculated as the sum of all items (possible range = 0–12). Omega reliability was good (0.83 at baseline and 0.89 at follow-up).

Ability to relax physical tension was measured using the 2-item relaxation subscale of the MOCS-A [36]. Items reflecting participants' ability to relax physical tension (e.g., "I am able to use mental imagery to reduce any tension I experience") were rated using the same 0–4 rating scale described above. Total relaxation ability scores were calculated as the sum of both items (possible range = 0–8). Items were moderately strongly correlated ($r = 0.51$ at baseline, $r = 0.49$ at follow-up).

Worry Three items selected from the full 16-item Penn State Worry Questionnaire (PSWQ) measured participants' general tendency to worry [38]. Items such as "many situations make me worry" were scored from 1 ("not at all typical of me" to 5 "very typical of me.") Total scores were taken as the sum of all items (possible range = 3–15). The PSWQ has demonstrated reliability and validity in measuring change in worry amongst cancer patients [39]. Omega reliability was good (0.89 at baseline, 0.87 at follow-up).

Resiliency The 23-item Current Experiences Scale (CES) measured resiliency as defined for the SMART-3RP [9]. Items are designed specifically to capture areas of growth targeted in the SMART-3RP, such as gratitude (e.g., "I appreciate every day"), and were scored on an agreement scale from 0 ("not at all") to 5 ("to a very great degree"). Total scores were the sum of all items (possible range = 0–115). The CES demonstrates good psychometric properties among stressed samples, including individuals with cancer and other medical concerns [9]. Omega reliability was excellent (0.90 at baseline, 0.91 at follow-up).

Analysis

Given our primary focus on pre-post intervention change, analyses were limited to the $n = 105$ study participants with

sufficient data to calculate a pre-post change score for at least one mediator for structural equation models. Within this sample of 105 individuals who completed at least one measure pre- and post-program, complete cases were used for univariate and bivariate statistics ($ns = 92-104$). In multivariate structural equation modeling, missing data were managed using full information maximum likelihood (FIML) estimation, which allowed for use of all available information [40]. Chi-square analyses and t -tests examined preliminary sociodemographic and treatment-related correlates of study variables. Initial descriptive statistics and pre-post intervention change scores were estimated in SPSS (v28), using paired sample t -tests and Cohen’s D as a standardized effect size (0.2 = small, 0.5 = medium, 0.8 = large). Bivariate Pearson correlations examined the strength of associations between study variables at baseline and pre-post change. Two-tailed statistical significance was set at $p < 0.05$.

Parallel mediation models were tested in MPLUS (v8.4). We used Montoya and Hayes’ (2017) framework for two-time point within-participant mediation [41] to assess the extent to which participation in the SMART-3RP drove changes in resiliency through change in 5 parallel indirect pathways: (1) ability to use relaxation to relieve somatic symptoms of stress, (2) mindfulness, (3) positive affect, (4) ability to assertively seek out social support, and (5) worry. These pathways were selected to map closely onto the theoretical framework for the SMART-3RP [9, 12]. Briefly, this model treats the passage of time as “path a” and the association between change in mediator (i.e., $M_2 - M_1$) and change in outcome (i.e., $Y_2 - Y_1$) as “path b” in a traditional “ $a \times b$ ” indirect pathway [41, 42]. Within this model, the average value of each mediator pre- and post-intervention (i.e., $(M_1 + M_2) \times 0.5$) is held constant to relax the assumption that the mediator and outcome variable are equivalently correlated at study start and end. The average value of each mediator was mean centered and constrained to be 0, thus freeing 5 degrees of freedom in an otherwise just-identified structural model. Indirect pathways were estimated using 10,000 bootstrapped samples to account for non-normality

of indirect effects. Pairwise differences in indirect effects were tested using subtraction in MPLUS (e.g., $ab_1 - ab_2$) [41].

Results

Compared to the $n = 105$ participants with complete pre-post data on at least one mediator who were included in the present study, participants with missing data ($n = 87$) were younger ($M = 53.3 \pm 11.7$ vs. $M = 58.3 \pm 11.4$, $t(177) = -2.85$, $p = 0.01$, $d = -0.43$) and attended fewer intervention sessions ($M = 5.45 \pm 2.83$ vs. $M = 7.64 \pm 1.19$; $t(106.57) = -6.63$, $p < 0.001$, $d = -1.05$). No group differences in baseline self-report measures, demographics, or treatment intent were significant ($ps > 0.08$).

Within this sample of $n = 105$ ($n = 104$ with available data for session attendance), most cancer survivors (93.3%; $n = 97$) attended at least six sessions. The majority attended groups entirely in person ($n = 76$, 73.1%), with 25.0% ($n = 26$) attending entirely remotely during the COVID-19 pandemic and 1.9% ($n = 2$) beginning the program in person and transitioning to virtual group meetings during the start of COVID-19 restrictions on in-person services in March 2020. Descriptive statistics and strength of pre-post change, calculated based on complete pre-post data, are summarized in Table 1.

Cancer survivors demonstrated moderate improvements in resiliency over the course of the intervention (see Table 1). Survivors also exhibited moderate-to-large rates of improvement across all mediating variables. The strongest improvements were evidenced in relaxation ability, with the most modest change in assertive social support-seeking.

Bivariate associations: baseline

At baseline, mediators demonstrated very small ($r = 0.04$, relaxation with a positive affect) to moderately sized ($r = -0.46$, mindfulness with worry) cross-sectional associations. Resiliency had small ($r = -0.11$ for worry and

Table 1 Descriptive statistics pre- and post-intervention

| | Pre: M (SD) | Post: M (SD) | Pre-post change | Cohen’s D |
|-----------------|---------------|----------------|-------------------------|-------------|
| Resiliency | 77.99 (14.23) | 84.32 (13.32) | $t(95) = -4.89^{***}$ | -0.50 |
| Relaxation | 2.62 (1.76) | 4.28 (1.78) | $t(101) = -10.17^{***}$ | -1.01 |
| Mindfulness | 31.46 (5.09) | 33.71 (4.98) | $t(93) = -5.20^{***}$ | -0.54 |
| Positive affect | 32.86 (6.28) | 35.91 (5.87) | $t(98) = -5.72^{***}$ | -0.58 |
| Social support | 5.62 (2.48) | 6.78 (2.78) | $t(101) = -4.67^{***}$ | -0.46 |
| Worry | 8.54 (3.59) | 7.23 (3.16) | $t(95) = 5.24^{***}$ | 0.53 |

*** $p < 0.001$. Initial mean comparisons use complete data for each measure: $n = 96$ for resiliency and worry, $n = 102$ for relaxation and social support, $n = 94$ for mindfulness, $n = 99$ for positive affect. Relaxation refers to participants’ perceived ability to relax physical tension; social support refers to participants’ ability to assertively seek social support as needed

resiliency) to moderately large ($r=0.60$, positive affect and resiliency) correlations with theoretical mediators. See Table 2.

Bivariate associations: change scores

Interrelations between changes in mediators ranged from very small ($r=0.02$, relaxation with mindfulness and worry) to moderately sized ($r_s=0.42$, mindfulness with worry and positive affect). Bivariate associations between changes in mediators and resiliency ranged from $r=0.07$ (relaxation with resiliency) to $r=0.50$ (positive affect with resiliency). See Table 3.

Parallel mediation model

We considered a parallel mediation model including five concurrent mediated paths: the ability to relax physical tension, mindfulness, positive affect, assertive social support-seeking, and worry. We first tested hypothesized a, b, and c paths to examine the appropriateness of indirect ($a \times b$) effect testing [41, 42]. The structural equation model testing these paths demonstrated excellent fit ($X^2(5)=0.029$, $p=1.00$; CFI=1.00; TLI=1.00; RMSEA=0.00, 90% CI[0.00, 0.00], SRMR=0.002. Results of the final path model tested are summarized briefly below, with full results reported in Fig. 1 and Supplementary Table 1.

Path C (mean difference in Y) Including all indirect paths, the total effect (c) of intervention participation on total resiliency was $B=6.66$ ($p<0.001$). With all paths held constant, the direct effect (c') of intervention on resiliency was no longer statistically significant ($B=2.02$, $p=0.27$).

Path A (mean difference in M) The direct effect of intervention participation on all five hypothesized mediators was statistically significant, indicating improvements across domains: ability to relax physical tension $B=1.67$, mindfulness $B=2.32$, positive affect $B=3.15$, assertive social support seeking $B=1.17$, worry $B=-1.32$ (all $p_s<0.001$).

Path B (difference in M predicting difference in Y) With all concurrent paths held constant, only change in mindfulness ($B=0.75$, $p=0.01$) and positive affect ($B=0.86$, $p=0.001$) remained significantly positively associated with change in resiliency. Adjusted associations between change in relaxation abilities ($B=-0.11$, $p=0.89$), assertive social support seeking ($B=0.80$, $p=0.12$), and worry ($B=0.42$, $p=0.41$) were not statistically significant.

Finally, we estimated indirect pathways ($a \times b$). Consistent with the results for paths a and b above, indirect effects of intervention participation on resiliency via change in mindfulness ($ab=1.74$, $p=0.02$) and positive affect ($ab=2.71$, $p=0.01$) were statistically significant. Indirect pathways via ability to relax physical tension ($ab=-0.18$, $p=0.89$),

Table 2 Bivariate correlations between study variables at baseline

| | Resiliency | Relaxation | Mindfulness | Positive affect | Social support | Worry |
|-----------------|------------|------------|-------------|-----------------|----------------|-------|
| Resiliency | 1 | | | | | |
| Relaxation | 0.23* | 1 | | | | |
| Mindfulness | 0.48*** | 0.09 | 1 | | | |
| Positive affect | 0.60*** | 0.04 | 0.37*** | 1 | | |
| Social support | 0.39*** | 0.26** | 0.17^ | 0.11 | 1 | |
| Worry | -0.11 | 0.11 | -0.46*** | -0.07 | 0.06 | 1 |

*** $p<0.001$; ** $p<0.01$, * $p<0.05$. ^ $p<0.10$. Complete n for bivariate correlations ranges from 101 to 103. Relaxation refers to participants' perceived ability to relax physical tension; social support refers to participants' ability to assertively seek social support as needed

Table 3 Bivariate correlations between change (post-pre) in study variables

| | Resiliency | Relaxation | Mindfulness | Positive affect | Social support | Worry |
|-----------------|------------|------------|-------------|-----------------|----------------|-------|
| Resiliency | 1 | | | | | |
| Relaxation | 0.07 | 1 | | | | |
| Mindfulness | 0.41*** | 0.02 | 1 | | | |
| Positive affect | 0.50*** | 0.16 | 0.42*** | 1 | | |
| Social support | 0.36*** | 0.25* | 0.38*** | 0.36*** | 1 | |
| Worry | -0.10 | 0.02 | -0.42*** | -0.16 | -0.13 | 1 |

*** $p<0.001$; ** $p<0.01$, * $p<0.05$. Complete n for bivariate correlations ranges from 92 to 96. Relaxation refers to participants' perceived ability to relax physical tension; social support refers to participants' ability to assertively seek social support as needed

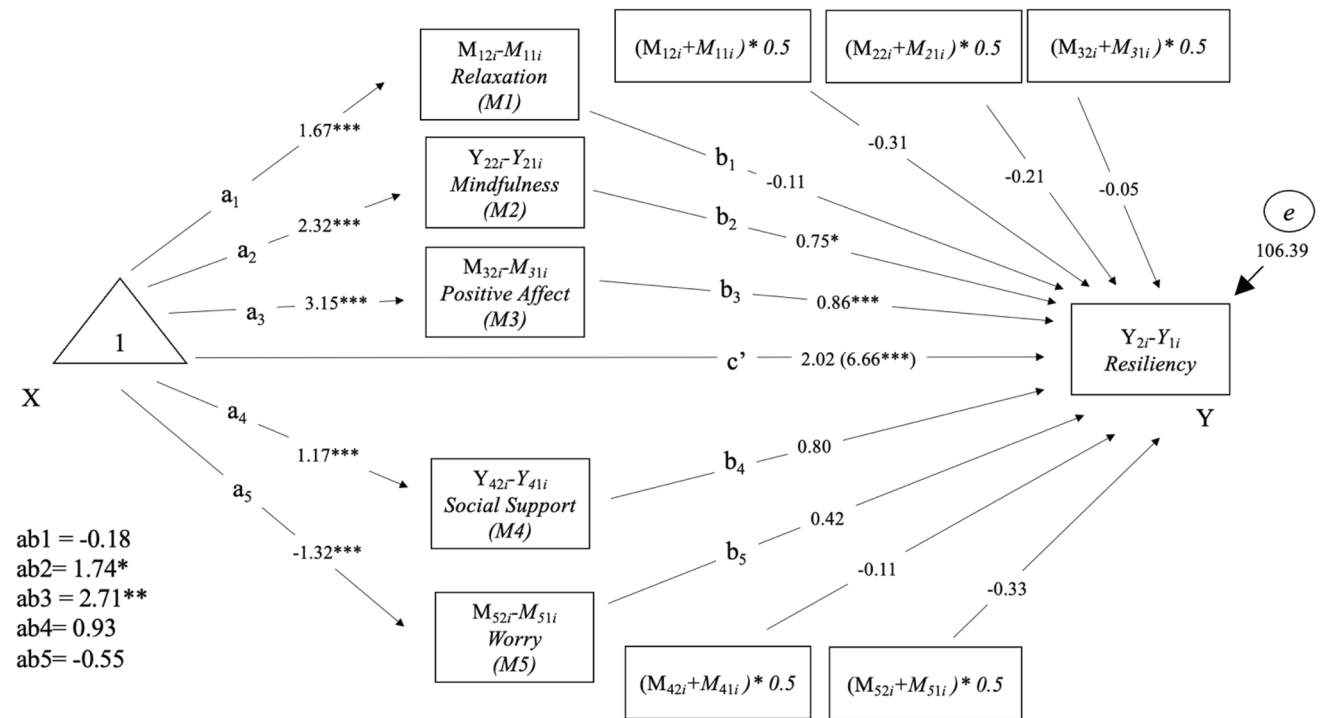


Fig. 1 Final path model with unstandardized coefficients ($n = 105$). Notes: *** $p < 0.001$; ** $p < 0.01$, * $p < 0.05$. The triangle at the left side of the diagram represents an intercept of pre-post change in mediators (i.e., treatment effect). Coefficients are unstandardized.

assertive social support-seeking ($ab = 0.93$, $p = 0.16$), and worry ($ab = -0.55$, $p = 0.42$) were not statistically significant. Pairwise comparisons between strength of mediated paths are elaborated in supplemental Table 2.

Discussion

This study examined the strength of change in psychological resiliency and five key intermediary variables targeted in the SMART-3RP intervention for cancer survivors, as well as cross-sectional and longitudinal associations between these constructs. Findings describe an exploratory test of a parallel mediation model through which positive psychological constructs mediate intervention effects on resiliency, as proposed in conceptual frameworks of the SMART-3RP [9, 12]. Findings resonate with the Resiliency Framework presented by Park and colleagues [9, 12], which suggests that a program based in CBT, positive psychology, and mind–body medicine may enhance coping and stress management abilities, which in turn foster resiliency as the ability to enjoy positive experience in the face of stress. In addition to our application of empirical data to this theoretical model, we further add to recent literature validating a novel measure of

Covariances between exogenous variables are omitted from this diagram for parsimony. Relaxation refers to participants' perceived ability to relax physical tension; social support refers to participants' ability to assertively seek social support as needed

resiliency (CES) [9] by examining cross-sectional and change score correlations between the CES and several theoretically related psychological constructs in a moderately large clinical sample of cancer survivors. Findings support the preliminary efficacy of the SMART-3RP for survivors of various cancers treated in our hospital clinic, with moderate-to-large effect sizes for all hypothesized mediators (ability to relax physical tension, mindfulness, positive affect, assertive social support-seeking, and worry) as well as total resiliency.

In the present study, we found that mindfulness, positive affect, and (to a lesser extent) assertive social support-seeking represented proximal mediators of program participation on resiliency. Our results illustrate that changes in positive affect and mindfulness uniquely covary with changes in resiliency above and beyond their overlap with other theorized mediators. Thus, these constructs are both theoretically and empirically supported as central intervention targets for resiliency interventions serving cancer survivors. Consistent with these results as well as the theoretical Resiliency Framework, the SMART-3RP strongly emphasizes mindful awareness and acceptance of stress, as well as behavioral strategies explicitly intended to increase positive experience (e.g., focus on gratitude and appreciation) [9, 12].

Similar to other mind–body cognitive-behavioral interventions for cancer survivors [4, 13, 22], participants' ability to relax

physical tension increased with a large effect size over the course of participation in the SMART-3RP. However, in contrast to the significant associations between mindfulness, positive affect, and resiliency, the ability to relax physical tension, which is more distal in the Resiliency Framework [9, 12], had minimal direct association with resiliency. It is also possible that changes in relaxation did not mediate improvements in resiliency as expected due to our focus on a multifactorial resiliency outcome, including behavioral, relational, and spiritual indices of resiliency in addition to positive emotional states alone (as in previous work [22]). Notably, many concurrent indirect pathways tested were statistically similar (see Supplementary Table 2), suggesting that it will be important for future randomized controlled trials to replicate these exploratory findings using a control group that better allows for direct comparison of mediated paths.

Although the two-time point design of the present analyses precluded consideration of a more complex serial mediation model (e.g., changes in mindfulness driving changes in relaxation and assertive social support-seeking abilities, which might in turn drive change in resiliency, as described in the Resiliency Framework [9, 12]), our finding that correlations between mindfulness and assertive social support-seeking change scores ($r=0.38$) were stronger than correlations at baseline ($r=0.17$) suggests that changes in assertive social support-seeking may be interdependent with changes in mindfulness such that changes in one domain drive changes in the other. Assertive social support-seeking and positive affect followed a similar pattern (change $r=0.36$; baseline $r=0.11$). Surprisingly, the ability to relax physical tension had minimal associations with change in positive constructs and at baseline, suggesting that even participants who experienced minimal change in mindfulness, positive affect, or worry may still be able to develop specific skills to relax physical tension by participating in a mind–body program such as the SMART-3RP.

In contrast to previous findings in a general stressed sample [9], resiliency and worry were not significantly correlated. This may be attributed to the use of an abbreviated PSWQ in the present study. It may also be the case that cancer-specific worry, such as fear of cancer recurrence, is more closely related to resiliency than general worry that is not cancer-specific [13]. Future research should distinguish the differential implications of health-focused worry versus other types of worry for psychological resiliency among cancer survivors.

Study limitations

Several limitations should be noted. Brief 2–3 item measures were used for several patient-reported outcomes, which may have limited our ability to detect significant covariance with longer measures of mindfulness, positive affect, and

resiliency (see Supplementary Table 1 for greater detail on observed variance). Although we used a rigorous mediation modeling technique [41], additional mid-program and follow-up assessments would allow for more nuanced modeling of change during and after the 8-week program. The use of a control group would also strengthen the evidence for the efficacy of the SMART-3RP. It should also be noted that the analyses reported here were limited to data from participants who volunteered to complete optional research surveys and so these results may be most representative of participants with relatively minimal barriers to engaging in a time-intensive mind–body program. Also relevant to the generalizability of study findings, our sample was relatively homogenous with regard to race and ethnicity, highlighting a need for greater inclusion of diverse populations in survivorship programming and mind–body medicine more broadly. Finally, approximately one-quarter of participants joined groups virtually due to the limitations of the COVID-19 pandemic, rather than attending in person as originally intended when the program was designed. We also did not assess participants' perceptions of group cohesion or availability of social support in their networks outside of the group but rather their perceived ability to assertively seek social support when needed. Moving forward, the inclusion of these aspects of social support would provide important context for understanding patients' experience of this clinical program.

Clinical implications and conclusion

Taken together, the results of the present study suggest that mindfulness and brief exercises to enhance positive affect may be particularly important elements of resiliency interventions for cancer survivors. Although relaxation, assertive social support-seeking, and reduced worry did not uniquely drive post-intervention changes in resiliency, they did change significantly over the course of program participation. These constructs may represent important standalone outcomes above and beyond their associations with psychological resiliency; for example, the ability to effectively relax physical tension is of great importance to many cancer survivors due to the myriad long-term physical health sequelae of cancer treatment. As such, these results provide promising support for use of the SMART-3RP and other mind–body group interventions. Consistent with the SMART-3RP framework [9, 12], future studies may expand upon these findings by collecting data at three or more time points and evaluating a serial mediation model in which intervention elements such as relaxation practice drive changes in mindfulness and/or positive affect, which in turn account for changes in resiliency.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00520-022-07022-5>.

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Author contribution All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by Lucy Finkelstein-Fox, Elyse Park, Daniel Hall, Giselle Perez, Amy Comander, Autumn Rasmussen, and Cathy Wang. The first draft of the manuscript was written by Lucy Finkelstein-Fox and Autumn Rasmussen, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability The data that support the findings of this study are available upon reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declarations

Ethics approval Study procedures were approved by the MGH IRB (protocol #2011P001081). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare no competing interests.

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