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Mindfulness and Sex Education for Sexual Interest/Arousal Disorder: Mediators and Moderators of Treatment Outcome

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ABSTRACT

Sexual Interest/Arousal Disorder (SIAD) is a common sexual dysfunction in women. Both mindfulness-based cognitive therapy (MBCT) plus psychoeducation and sex therapy, education, and support (STEP; which contains the same educational information as in the MBCT arm but also integrates supportive-expressive therapy), are effective. We tested mediators and moderators of improvements. Each treatment arm consisted of eight sessions delivered weekly, and participants completed measures online pre-treatment, immediately post-treatment, and at 6- and 12-month post-treatment. Depression, self-reported interoceptive awareness, self-compassion, self-criticism, and mindfulness were examined as mediators, and expectations for improvement as a moderator. Of 148 cisgender women who consented, 70 were randomized to the MBCT plus psychoeducation group (mean age 39.3 ± 13.2 yrs) and 78 to the STEP group (mean age 37.9 ± 12.2 yrs). Decreases in depression mediated decreases in sexual distress in the MBCT plus psychoeducation group only. Improvements in interoceptive awareness mediated changes in both sexual desire and arousal, and sexual distress, and to a greater degree after MBCT plus psychoeducation. Changes in self-compassion mediated changes in sexual desire and arousal only for the MBCT plus psychoeducation group and mediated changes in sexual distress in both groups. Reductions in self-criticism mediated improvements in sexual distress to a greater extent after MBCT plus psychoeducation. Changes in mindfulness predicted changes in desire and arousal, and distress only in the MBCT plus psychoeducation group. Expectations for improvement did not moderate any outcomes. The findings have implications for understanding common and potentially distinct pathways by which MBCT plus psychoeducation and supportive sex education improve symptoms of SIAD.

Introduction

A lack of interest in sexual activity that elicits clinically significant personal distress and interferes in a person's life is a common experience for women. The official diagnosis is Sexual Interest/Arousal Disorder (SIAD) (gender specific) as per the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* (American Psychiatric Association, 2013), and occurs when a woman meets at least three of six criteria for six months, including: lack of interest (or no interest) in sexual activity; to absent or interest in sexual activity, reduced level of initiating sex and/or responding to a partner's sexual advances, reduced pleasure during sexual activity, lack of responsive sexual desire (or desire that emerges after one becomes sexually aroused), and reduced genital and non-genital sensations (i.e., arousal). Several large population-based studies have sought to determine the prevalence of low desire, and one of the more representative population-based studies, called the National Survey of Sexual Attitudes and Lifestyles (NATSAL-3), was carried out in the UK and assessed 6777 women. Among those who had a sexual partner in the last year, 34.2% of women across ages endorsed low desire (Mitchell et al., 2013). When focused more specifically on the SIAD criteria, a different population-based study revealed a prevalence of 0.6% (Mitchell et al., 2016). Over the past decade, there has been a considerable increase in research on psychological treatments for low desire in women (Frühauf et al., 2013) though the mechanisms by which these treatments work are minimally understood. The goal of the present study was to examine putative mediators, as well as treatment expectations as a moderator, underlying the effects of two psychological treatments for SIAD. The first treatment being investigated is mindfulness-based cognitive therapy, which involves practicing skills of present-moment, non-judgmental awareness, combined with psychoeducational information pertaining to sexual desire and response. The second treatment investigated was is the same psychoeducational material but delivered by group therapists in a supportive-expressive manner that encourages validation and support among group participants.

The Incentive Motivation model (IMM; Singer & Toates, 1987; Toates, 2009) is a leading theory of sexual response, which posits that sexual desire and arousal are reciprocally reinforcing, and that sexual desire emerges after one experiences sexual arousal. The experience of sexual desire reinforces a person's initial sexual motivation. Key to this process is engaging with a sexual stimulus (also called trigger or cue)

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which automatically engages cognitive and physiological systems to prepare the body for sexual activity. This then elicits sexual arousal and triggers sexual desire, otherwise known as responsive sexual desire (Basson, 2001).

Psychological factors can interrupt this process, such as cognitive distraction during sexual activity, which draws attention away from erotic cues (Dove & Wiederman, 2000), as well as behavioral avoidance and anxiety (Barlow, 1986). Negative beliefs about oneself or about sex can also directly impair sexual desire and make women more vulnerable to activation of negative self-schemas, defined as global beliefs about oneself that lead to problematic ways of thinking (specifically those of incompetence) when they are in a sexual encounter (Nobre & Pinto-Gouveia, 2006). Such self-critical schemas interfere with a person's ability to focus on the sexual stimuli, which, according to IMM, further impairs sexual response. Thus, psychological treatments that target the relationship between awareness of sexual stimuli and responsive sexual desire are seen as promising for improving sexual desire.

Mindfulness-based approaches aim to cultivate intentional awareness of body sensations with acceptance, nonjudgment, and compassion. A systematic review and meta-analysis found mindfulness-based therapy to significantly improve sexual desire and other facets of well-being (Banbury et al., 2021); however, randomized clinical trials examining efficacy of mindfulness-based therapy are rare. One exception is a recent randomized trial where an eight-session mindfulness-based cognitive therapy (MBCT) plus psychoeducation was compared to psychoeducation alone delivered using principles of supportive-expressive therapy (Brotto et al., 2021). Compared to the psychoeducation group, MBCT led to significantly greater improvements in sexual distress, relationship satisfaction, and rumination, and these effects persisted when participants were assessed 12 months later. The supportive sex education group was as effective as the MBCT plus psychoeducation group for improving the primary outcome of sexual desire (Brotto et al., 2021). Given that supportive sex education was comparable to MBCT plus psychoeducation for improving sexual desire, there is a need to understand the putative mediators underlying these findings and to understand the mechanisms by which MBCT was superior to the comparison group for sexual distress.

One review of the literature speculated that MBCT may improve sexual desire by targeting mindfulness and decentering (i.e., maintaining distance from one's thoughts and feelings) directly, but also by improving interoceptive awareness, depressed mood, and anxiety (Arora & Brotto, 2017). Drawing from the IMM (Toates, 2009), it is possible that MBCT increases women's attention to sexual cues and/or increases their interoceptive awareness of their own body sensations. Evidence for these putative mechanisms comes from the finding that mindfulness training improves reaction time to noticing physiological sensations following exposure to sexual stimuli (Silverstein et al., 2011), and evidence from an uncontrolled trial indeed found changes in interoception to mediate improvements in sexual desire after MBCT (Paterson et al., 2017).

Mindfulness likely also removes psychological barriers to sexual arousal, in part by decreasing rumination and negative affectivity (e.g., Brotto et al., 2021; Lindsay & Creswell, 2017), both of which are strongly associated with depression (Kircanski et al., 2012; Papageorgiou & Siegle, 2003). Change in depressive thinking is a key mediator by which MBCT leads to clinical improvements (Alsubaie et al., 2017; Gu et al., 2015; van der Velden et al., 2015), and in line with this, improvements in depressive symptoms during MBCT mediated improvements in overall sexual function in an uncontrolled trial (Paterson et al., 2017). The extent to which changes in depressive symptoms mediate improvements in sexual desire and sexual distress following MBCT versus supportive sex education is unknown. Whereas MBCT targets depression through mindfulness of thought practices (which are designed to promote metacognitive awareness; Solem et al., 2017), supportive sex education might also target depression through the validation and support of other group participants, and as such, it is possible that changes in depression underlie improvements in clinical outcomes after both MBCT and supportive sex education.

Self-compassion is the tendency to be open to one's own suffering, not avoiding or disconnecting from it, and generating desire to alleviate suffering with kindness (Neff, 2003). Research recommends measuring general self-compassion on two dimensions: positively worded self-compassion and negatively worded self-criticism (Costa et al., 2016; Neff, 2016). Although many MBCT programs do not directly include self-compassion practices, it is well known that mindfulness practice itself can cultivate self-compassion simply by having facilitators embody kindness and compassion in their guiding of all practices (Segal et al., 2012). In women with SIAD, an uncontrolled trial showed that improvements in self-compassion after MBCT plus psychoeducation mediated improvements in overall sexual function (Paterson et al., 2017). Self-compassion also mediated improvements in sexual distress with MBCT among women with genital pain, whereas it did not mediate improvements after cognitive behavioral therapy, suggesting that it was mindfulness training specifically that induced self-compassion which then impacted clinical outcomes (Brotto et al., 2020). The extent to which improvements in desire and distress are mediated by changes in self-compassion specifically after MBCT, as opposed to after psychoeducation, have never been studied.

It has long been asserted that mindfulness-based interventions benefit clinical outcomes because they cultivate mindful awareness (Segal et al., 2002). The mediating effects of mindfulness have not been consistently evaluated, however. Given that MBCT involves the explicit daily practice of mindfulness, which seeks to cultivate present-moment and non-judgmental awareness, it would be expected that improvements in mindfulness may underlie the effects of MBCT on sexual desire and distress. A systematic review of 14 studies of varying methodological quality found improvements in mindfulness to mediate improvements in clinical outcomes (Gu et al., 2015). In fact, compared to other mediators, changes in mindfulness are one of the strongest mediators regardless of whether the outcome was depression or anxiety (Alsubaie et al., 2017). Changes in mindfulness mediated improvements in genital pain after MBCT but not after cognitive-behavioral therapy

(Brotto et al., 2020) and they also mediated the effects of MBCT on overall sexual function for women with SIAD (Paterson et al., 2017). Whether changes in mindfulness mediate improvements after sex education has not been studied.

Treatment outcome expectations can produce changes in an outcome variable that are not due to the active ingredients of the intervention (Constantino et al., 2018). One way of measuring treatment expectations is via treatment credibility or the degree to which patients think a treatment is logical in reducing one's symptoms (Boot et al., 2013). Following an 8-week MBCT in women with genital pain, those with higher expectations for treatment improvement tended to improve more on the outcome of genital pain (Brotto et al., 2020). On the other hand, in an uncontrolled trial of 8-week MBCT for women with SIAD, baseline treatment expectations did not significantly moderate outcomes on sexual desire or distress (Paterson et al., 2017). Here, we explored treatment expectations as a moderator of outcomes in both MBCT plus psychoeducation and supportive sex education alone without mindfulness.

Goals of the Study

The goal of the present study was to examine the psychological mechanisms by which MBCT improves sexual desire and sexual distress in women with SIAD, over and above their mediating effects after supportive sex education. Given that psychological treatment studies in the context of sexual dysfunction have been heavily criticized for not exploring mediators nor evaluating treatment expectations (Pyke & Clayton, 2015), the current study was seen as addressing this critical gap in the literature. We predicted that improvements in depression, self-reported interoceptive awareness, self-compassion, self-criticism, and mindfulness would uniquely predict improvements in sexual distress and desire in MBCT but not in the supportive sex education group (this hypothesis was somewhat tentative for depression, which might also mediate outcomes in the supportive sex therapy arm). While we therefore predicted that improvements in interoception would mediate improvements in sexual desire (and possibly sexual distress) in MBCT plus psychoeducation, we did not expect these same mediation effects in the supportive sex education treatment because it contained only minimal discussion of interoceptive awareness training through discussion of Sensate Focus. With regard to self-compassion, which is directly taught in the MBCT plus psychoeducation but not in the STEP arm, we also predicted that improvements in self-compassion would mediate changes in sexual desire and sexual distress in the MBCT arm only. We expected the same for changes in self-criticism as a mediator. We did not expect changes in mindfulness to underlie effects of supportive sex education on sexual desire and distress since the practice of nonjudgmental awareness of sensations, which is key to mindfulness, was not a focus of the supportive sex education intervention. We also predicted that baseline expectations for treatment improvement would predict improvements in both treatment arms; however the strength of such a relationship may vary between the treatments and therefore exploratory higher level interaction of expectations and treatment were also examined. To the best of our knowledge, this is the first examination of mediators of MBCT plus psychoeducation for SIAD in the context of a randomized clinical trial. A sum score measure of desire and arousal was our co-primary endpoint (given that the diagnostic criteria for SIAD include symptoms of low desire and impaired arousal) along with sexual distress.

Materials and Method

Participants

Participants were 148 women who endorsed symptoms consistent with SIAD. Inclusion criteria were assessed during a telephone screen by a trained research coordinator and included: (1) a tentative diagnosis of SIAD that was assessed by asking women the six SIAD criteria plus assessing the presence of significant personal distress; (2) symptoms occurring for at least 6 months; (3) ability to attend eight weekly treatment sessions; (4) age 19 years or older; (5) fluent in English; and (6) a willingness to not begin any new treatments for low desire for the duration of the study until the 6-month follow-up point. Exclusion criteria were as follows: (1) a current untreated psychiatric or medical condition that would make attending group sessions difficult; (2) self-report of significant vulvovaginal pain that accounted for the loss of sexual desire; and (3) self-reported symptoms of significant dissociation (which could make participation in mindfulness-based therapy challenging; Kuyken et al., 2012). A diagnosis of SIAD was verified during the pre-group in-person assessment with one of the group facilitators when participants endorsed at least three of the SIAD criteria plus self-reported clinically significant personal distress. The same participants were reported on in Brotto et al. (2021).

Procedure

Immediately after completing the baseline questionnaires, participants were randomized (using cluster randomization at a group level) to attend either eight weeks of group MBCT or group supportive sex education (hereinafter, STEP). Participants were emailed a link to the online questionnaires, which they completed at all time points: pre-treatment (t1), then again at 2–4 weeks after the eighth session of treatment (t2), and at 6- and 12-month follow-up (t3 and t4). All participants provided written consent for treatment and research, and the study was approved by both the Clinical Research Ethics Board at the University of British Columbia (H12-01659) and the associated Vancouver Coastal Health Research Institute Research Ethics Board (for detailed description of the procedures, see Brotto et al., 2021). The study and hypotheses were registered at ClinicalTrials.gov NCT01690897.

Treatments

Briefly, both treatments were delivered over eight weekly sessions, 2.25 hours in length, by sexual health clinicians who had additional training in mindfulness-based interventions and had their own personal mindfulness practice. There were two facilitators for every group, and the

number of participants in each group ranged from 3 to 10 with 88% of groups including 5–9 participants. Twelve MBCT and 13 STEP groups were formed and went through treatment. Although all facilitators could lead both MBCT and STEP groups, none of them led different groups at the same time, in order to adhere to the theoretical orientation of the group they were running at the time.

Mindfulness-Based Cognitive Therapy (MBCT) Plus Psychoeducation. The MBCT plus psychoeducation intervention focused the first hour of each session on an in-session mindfulness practice plus a guided inquiry. Mindfulness practices included an eating meditation, body scan, breath awareness practice, mindfulness of thoughts (to promote metacognitive awareness), mindful movement, and eliciting a difficulty meditation. Self-compassion was embodied in how the facilitators guided the mindfulness exercises, and in how they asked questions during the guided inquiry, though there was no specific compassion meditation, consistent with MBCT for depression (Segal et al., 2012). There were also several mindfulness practices that were done following exposure to touching the body or after interacting with a sexual stimulus (e.g., vibrator, fantasy, or erotica) at home. The second half of the MBCT session included psychoeducational information, which is below on in more detail in the section describing STEP. Notably, this psychoeducational material was delivered in a didactic way and did not include validation or support among the group members. Following each session, participants were emailed a link to audio guided mindfulness practices and they were encouraged to practice at home daily prior to the next session. They were also encouraged to record their observations of the practice on a daily log in addition to whether they did the practice and for how many minutes.

Group Supportive Sex Education and Therapy (STEP). The STEP intervention included all of the same educational information that was included in the MBCT arm but instead of being delivered in a purely didactic way, it was delivered in a manner that encouraged participants to interact with and validate one another in a supportive way. The educational instruction included: education about the sexual response cycle, prevalence of sexual concerns, the causes and perpetuating factors of low desire, and sensate focus, which was introduced in the last week, and which involved some minimal information on interoceptive awareness through its instructions to participants to pay attention to their body sensations while being touched by a partner. Since the STEP arm was of the same length and duration as the MBCT arm but did not include any mindfulness practice, the additional time was spent allowing participants to ask more questions and consistent with the principles of supportive expressive therapy (Leichsenring & Leibing, 2007), which were woven into the STEP arm, participants in the STEP group were encouraged to validate and ask questions of one another. No elements of mindfulness or cognitive-behavioral therapy were included in the STEP group.

Measures

Sexual Desire and Arousal

The 13-item Sexual Interest and Desire Inventory-Female (SIDI; Clayton et al., 2006) total score was used to quantify our primary outcome, a sum score measure of desire and arousal. It measures sexual desire and interest, arousability, responsive desire, initiation, affection, sexual thoughts, and response to erotica. Total scores, including all those dimensions, range from 0 to 51, with higher scores indicating greater sexual desire and arousal. One advantage of the SIDI over other similar measures is that it does not depend upon the participant's level of sexual activity. The SIDI has excellent internal consistency (Cronbach's α=0.90) and excellent criterion validity, correctly identifying 94.7% of women with hypoactive sexual desire disorder using a cut-off score of 33 (Clayton et al., 2010). In this sample, Cronbach's alpha at t1, 2, 3, and 4 was .82, .88, .86, and .87, respectively. Hypoactive sexual desire disorder was the diagnosis in the DSM-IV-TR (American Psychiatric Association, 2000) and differs from the diagnosis of SIAD in that it was a monothetic diagnosis that required deficient sexual fantasies and desire for sexual activity.

Sexual Distress

This was the second primary outcome and was measured with the 13-item Female Sexual Distress Scale – Revised (FSDS-R; Derogatis et al., 2008) which ranges from 0 to 52. The FSDS-R has excellent discriminant validity (Derogatis et al., 2008) and also does not depend on a participant's current level of sexual activity. Derogatis et al. (2002) also found satisfactory internal consistency (ranging from 0.86 to 0.90). In this sample, Cronbach's alpha at t1, 2, 3, and 4 was .93, .94, .96, and .96, respectively.

Mediators

The first mediator was depressive symptoms measured with the 7-Item Hamilton Rating Scale for Depression (HAMD-7) which asked about symptoms of Major Depressive Disorder on a 0 = "absent" or "no difficulty" to 4 (i.e., incapacitating or full symptoms) scale. The abbreviated 7-item version is equivalent to the full 17-item version in terms of assessing remission in people with major depressive disorder (McIntyre et al., 2005). The HAMD-7 is sensitive to treatment effects for depression (Lin et al., 2019) and has a high degree of reliability (Cronbach's alpha 0.51 – 0.84) and convergent validity when compared to longer measures of depression (McIntyre et al., 2005). In our sample, Cronbach's alpha for the total score was .66, .71, .75, and .70 at t1, 2, 3, and 4, respectively.

The second mediator was interoceptive awareness, measured with the 32-item Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2012). Questions were answered on a 6-point Likert scale ranging from 0 = "never" to 5 = "always". It measures eight dimensions of interoceptive awareness: noticing, not-distracting, not-worrying, attention regulation, emotional awareness, self-regulation, body listening, and trusting. We calculated a total score and used this as a mediator for both outcomes. The MAIA has been found to have high "internal-consistency" (.66 - .82) (Mehling et al., 2012). In our sample, Cronbach's

alpha for the total score was .78, .78, .81, and .81 at t1, 2, 3, and 4, respectively.

The third mediator was self-compassion, assessed with the 26-item Self-Compassion Scale (Neff, 2003), which measures different aspects of compassion and kindness toward oneself. Whereas the original measure produced six sub-domains of self-compassion, the subsequent research failed to confirm the higher-order single-factor structure and provided robust evidence for two domains of self-compassion and self-criticism (Costa et al., 2016; Neff, 2016); these two scales were used in this study. Higher scores indicate greater self-compassion and lower self-criticism, and both scale scores range from 1 to 5. In this sample, Cronbach's alpha at t1, 2, 3, and 4 was .88, .81, .85, and .84, respectively, for self-compassion and .86, .88, .89, and .88, respectively, for the self-criticism scale.

The final mediator examined was mindfulness, measured with the 39-item Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) total score. Total scores range from 39 to 195, with higher scores indicating greater mindfulness. The FFMQ has been found to have adequate to good internal consistency with alphas ranging from 0.72 to 0.92. In this sample, Cronbach's alpha at t1, 2, 3, and 4 was .63, .68, .70, and .74, respectively.

Moderators

Treatment outcome expectation was evaluated with two items immediately after the first treatment session so that participants could base their expectation on having some minimal information about the treatments. Participants in both groups were asked, "To what extent do you think the treatment you will receive is logical in terms of alleviating your sexual desire concerns?" (rated on a 0 *not at all logical to 10 completely logical scale*) and "To what extent do you expect improvement in your sexual desire as a result of this treatment?" (rated on a 0 *no improvement to 10 complete improvement scale*). Type of treatment was also used as a moderator.

Data Analysis Plan

We tested a moderated mediation model (see Figure 1) described as Model 5 in Preacher et al. (2007) and presented in Figure 10.1 panel C in Hayes (2013). We examined putative mediators of the treatment impact on sexual distress and sexual desire and arousal, and whether such mediation was conditional on the type of treatment (STEP versus MBCT plus psychoeducation). We assumed that the type of treatment (moderator variable in Figure 1) may affect path a, path b, or both, so we considered the moderated mediation to occur when either path a or path b or both were moderated.

Mediation was tested by a sequence of multilevel mixed models. The main predictor (time) consisted of the four time points (baseline-t1, post-treatment-t2, 6-month-t3 and 12-month follow-up-t4) entered as a continuous time variable in order to test the impact of treatment over time on the two outcomes. The mediators were represented by within-subject change scores at the four time points. Following the recommendations of Zhang et al. (2009) on testing mediation in multilevel models, the approach of mediator being centered within context with reintroduction of the subtracted mean (CWC(M)) was used by entering person-centered mediator variable and person mean as predictors in each model (Wang & Maxwell et al., 2015). Thus, each person's average across four time points (person intercept) was included as well as the difference scores between each time assessment and the person average (within-person change). This approach allows for examining the association of change in mediator with the change in outcome.

Since treatment was delivered in a small group setting, each participant was nested within their treatment group and the potential impact of within-group similarity was evaluated. Null model ICC calculations indicated very small correlations within treatment groups (.08 for sexual distress and .06 for the sexual desire/arousal outcome). Additionally, we first analyzed all predictive models including random treatment group

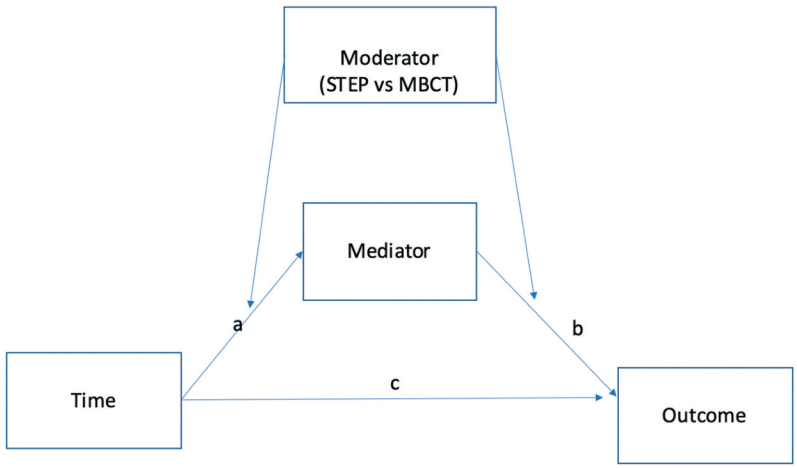

Figure 1. Model illustrating treatment type as a moderator of the mediated pathways from treatment to improvements in sexual desire and arousal, and distress. Mediators include self-compassion, depressive symptoms, interoception, self-criticism, and mindfulness. STEP = supportive sex education and therapy group; MBCT = mindfulness-based cognitive therapy plus psychoeducation group.

intercept. The variance explained by treatment group was either so close to zero that the model did not converge or slightly above zero explaining on average 3% of the variance accounted for by participant random intercept. Based on these results, we decided to drop treatment group nesting level from all analyses.

The moderated mediation was tested by first fitting a model for moderated path a in which the change in the mediator was regressed on time, type of treatment (STEP versus MBCT plus psychoeducation), and their interaction. A significant interaction term indicated that the impact of treatment on changes in the mediator was conditional on the type of treatment. Next, a model for moderated path b was fitted in which changes in the outcome were regressed on time, type of treatment (STEP versus MBCT plus psychoeducation), mediator and the interaction of type of treatment and mediator. A significant interaction term indicates that the impact of the changes in the mediator on the changes in the outcome was conditional on the type of treatment. Finally, the conditional indirect effect was computed by multiplying path a and path b unstandardized coefficients separately for STEP and MBCT plus psychoeducation arms. The significance of those indirect effects was estimated using the bootstrap method (Hayes, 2013; MacKinnon et al., 2002). In this approach, which is considered superior to other methods (e.g., Sobel test) when evaluating the presence of mediation (MacKinnon et al., 2002), multiple samples (at least 5,000 are recommended) of N cases each are drawn with replication from the original sample of N cases. Next, the mediation models are conducted on each sample. The indirect effect is computed as the product of path a and path b unstandardized coefficients and the 95% confidence interval for the values of this effect is established. It is assumed that the indirect effect is statistically significant if the 95% CI does not include zero (Preacher et al., 2007). Statistically significant indirect effects indicate the presence of mediation. In the case of moderated mediation, the bootstrap analysis is performed separately for selected levels of the moderator (in our case, separately for STEP and MBCT plus psychoeducation participants).

Mediation mechanisms and potential moderating effect of treatment were first tested on the original sample using multilevel models. Significant path a and b and significant interaction with treatment in either path model indicated presence of moderated mediation. Thus, the moderated mediation was present when either path a or path b or both were moderated. Bootstrap analysis of indirect effects computed separately for each treatment group confirmed the presence of mediation and elucidated how the mediation effect differed in the two treatment groups.

Following the IMMPACT recommendations (Turk et al., 2008), we did not correct for multiple tests. The consortium recommends that when secondary endpoints are analyzed in order to better understand the mechanisms behind a treatment and such analysis is accompanied by significant effects of treatment for all primary endpoints (as was the case in our study) then the correction for multiple comparisons is not necessary and the prespecified alpha level ($p < .05$) can be used to avoid loss of power (D'Agostino, 2000; Turk et al., 2008).

Moderation of treatment effects by treatment outcome expectation was examined using cross-level interactions in multilevel mixed model analysis. Treatment group and moderator baseline values were entered in the model as level-2 variables and allowed to interact with individuals' outcome scores at each time point (level-1 'time' variable). A significant three-way cross-level interaction would indicate a moderation effect of baseline moderator (treatment expectation questions) on changes in outcome variable across time, conditioned on treatment group. A significant two-way cross-level interaction of time and moderator would indicate impact of treatment expectation on the level of improvement regardless of the type of treatment.

All analyses followed the ITT (intention to treat) protocol with all randomized participants included. The analyses were conducted using IBM SPSS software. All data have been made publicly available at the Open Science Framework and can be accessed at https://osf.io/a34p6/?view_only=99a750a2134246f8bd298179dfa62b90

Results

Baseline Characteristics of Participants

A total of $n = 148$ cisgender women provided data at baseline, $n = 129$ provided data at post-treatment, $n = 121$ at 6-month follow-up, and $n = 114$ women provided data at 12-month follow-up. Dropout rates did not differ between treatment groups. Baseline participant characteristics are included in Table 1. Baseline and post-treatment descriptives for mediators and outcomes are presented in Table 2. A diagram showing the flow of participants from recruitment through to each of the follow-up stages has been published elsewhere (Brotto et al., 2021). There were no statistically significant differences between participants who dropped out and those who stayed until the end of the study on any of the characteristics listed in Table 1 or any of the baseline measures of outcomes or mediators.

Estimation of Mediation Paths on Original Sample

Multilevel random coefficient analyses of moderated mediation are presented in Table 3. Multilevel analyses on the original sample found that all path a and path b coefficients were significant, indicating that there was a significant change in the mediators following treatment and that the change in the mediators was significantly associated with changes in the outcomes. All effects were in predicted directions. Depressive symptoms and self-criticism decreased post-treatment, while interoceptive awareness, self-compassion, and mindfulness increased after treatment. The decrease in depressive symptoms and self-criticism were associated with increases in sexual desire and arousal, and decreases in sexual distress, while increases in interoceptive awareness, self-compassion, and mindfulness were associated with increases in desire and arousal, and decreases in sexual distress.

The moderating effect of treatment on path a (changes in mediators post-treatment) was significant for interoceptive awareness and mindfulness, which increased more in the MBCT plus psychoeducation arm than in the STEP arm, and

Table 1. Baseline characteristics of Participants in the Sex Education (STEP) and Mindfulness-Based Cognitive Therapy (MBCT) plus psychoeducation treatment arms.

Measure	STEP	MBCT Plus Psychoeducation	Total
Number of Participants	78	70	148
Age (years), mean ± SD	37.9 ± 12.2	39.3 ± 13.2	38.6 ± 12.6
Relationship status, n (%)			
Common-law	22 (28.6)	20 (29.4)	42 (29.0)
Dating	11 (14.3)	9 (13.2)	20 (13.8)
Married	30 (39.0)	31 (45.6)	61 (42.1)
Single	14 (18.2)	8 (11.8)	22 (15.2)
Length of current relationship (years), mean ± SD	11.9 ± 10.5	10.8 ± 10.1	11.4 ± 10.3
Satisfaction with relationship closeness, n (%)			
Yes	34 (45.9)	29 (43.3)	63 (44.7)
No	40 (54.1)	38 (56.7)	78 (55.3)
Ethnicity, n (%)			
East Asian	7 (9.1)	3 (4.3)	10 (6.8)
Euro-Canadian	60 (77.9)	57 (82.6)	117 (80.1)
Latin American	1 (1.3)	0 (0.0)	1 (0.7)
Middle Eastern	1 (1.3)	2 (2.9)	3 (2.1)
South Asian	2 (2.6)	4 (5.8)	6 (4.1)
Other	6 (7.8)	3 (4.3)	9 (6.2)
Sexual orientation, n (%)			
Bisexual	11 (14.1)	10 (14.5)	21 (14.3)
Heterosexual	62 (79.5)	52 (75.4)	114 (77.6)
Lesbian	3 (3.8)	4 (5.8)	7 (4.8)
Other	2 (2.6)	3 (4.3)	5 (3.4)
Education, n (%)			
High school	5 (6.5)	1 (1.4)	6 (4.1)
College/technical or trades	17 (22.1)	15 (21.7)	32 (21.9)
Undergraduate degree	35 (45.5)	28 (40.6)	63 (43.2)
Master's degree	15 (19.5)	23 (33.3)	38 (26.0)
Doctorate or MD	5 (6.5)	2 (2.9)	7 (4.8)
Significant medical history,[1] n (%)	27 (35.1)	27 (39.1)	54 (37.0)
Currently receiving hormone therapy, n (%)	13 (16.7)	4 (5.8)	17 (11.6)
Number of years with current sexual concerns, mean ± SD	9.1 ± 7.8	8.7 ± 8.0	8.9 ± 7.9
Report a history of sexual assault, n (%)	25 (32.1)	29 (42.0)	54 (36.7)
As an adult	17 (21.8)	20 (29.0)	37 (25.2)
As a child			
Received past treatments for low desire, n (%)	19 (24.4)	11 (16.2)	30 (20.5)
Treatment expectations: believe that the treatment is logical, mean ± SD	7.76 (1.69) Range 2-10	7.32 (1.94) Range 2-10	
Treatment expectations: expect improvement, mean ± SD	6.24 (1.45) Range 2-10	6.28 (1.67) Range 2-10	

[a]Reported medical conditions listed from most to least endorsed: inflammatory bowel disease (e.g., Crohn's, colitis), cancer, endometriosis, hypothyroidism, asthma, benign tumor/growths (e.g., fibroids, cysts), diabetes, genital herpes, celiac disease, high blood pressure, migraines, osteoarthritis, seizures, cervical dysplasia, chronic fatigue syndrome, fibromyalgia, heart condition, kyphosis, iron deficiency, Meniere's disease, monoclonal B cell lymphocytosis, multiple sclerosis, neutropenia, osteoporosis, sciatica, significant physical injuries, typhoid fever, vestibulitis.

for self-criticism, which decreased more after MBCT plus psychoeducation than after STEP. The treatment by time interaction also approached significance ($p = .079$) for changes in depressive symptoms, with MBCT plus psychoeducation participants showing larger improvement than STEP participants. The marginal significance is mentioned because the bootstrap analyses, which are considered more powerful than one sample models (MacKinnon et al., 2002), confirmed the conditionality of mediation for this mediator.

The moderating effect of treatment on path b (changes in mediators predicting changes in outcomes) was significant for changes in self-compassion predicting changes in sexual desire and approached significance for depressive symptoms predicting changes in sexual distress ($p = .061$) and for mindfulness predicting changes in sexual desire ($p = .068$) (again, marginal effects are mentioned for reasons described above).

Bootstrap Analyses

Bootstrap analyses testing significance and size of mediation effects are reported in Table 4. Changes in depressive symptoms did not mediate changes in sexual desire and arousal (in either group), while evidence of a moderated mediating effect was found for sexual distress – a decrease in depression mediated decrease in distress for MBCT plus psychoeducation group only. Changes in interoceptive awareness mediated changes in both sexual desire and arousal, and distress. This mediation was moderated by treatment – the mediation effect in MBCT plus psychoeducation group explained three times more variance than it did in the STEP group (26% versus 8%, respectively, for sexual desire and arousal, and 31% versus 10%, respectively, for sexual distress). Changes in self-compassion mediated changes in sexual desire and arousal only for the MBCT plus psychoeducation group (moderated mediation) and mediated changes in sexual distress for both treatment groups. Changes in self-criticism did not mediate sexual desire and arousal improvements in either of the groups; however, they mediated changes in sexual distress and that mediation was moderated by treatment; the mediation effect in MBCT plus psychoeducation group explained three times more variance than it did in the STEP group (15% versus 5%, respectively). Changes in mindfulness showed moderated mediation

Table 2. Descriptives for primary outcomes and mediators by time of assessment and treatment group.

Variable and Group	Baseline *M (SD)*	Post-Treatment *M (SD)*	6-Month Follow-Up *M (SD)*	12-Month Follow-Up *M (SD)*
Number of participants	148	129	121	114
Sexual desire and arousal (SIDI)[1]				
STEP	15.41 (6.66)	23.63 (9.91)	25.57 (10.77)	26.76 (11.51)
MBCT Plus Psychoeducation	16.99 (8.16)	27.91 (9.81)	28.08 (10.44)	29.85 (9.78)
Sexual distress (FSDS-R)[2]				
STEP	32.22 (7.99)	25.68 (10.24)	23.87 (11.83)	21.60 (11.95)
MBCT Plus Psychoeducation	32.97 (11.27)	22.88 (10.73)	23.02 (11.54)	18.92 (9.63)
HAMD[3]				
STEP	4.70 (3.62)	3.95 (3.79)	3.47 (3.60)	3.54 (3.13)
MBCT Plus Psychoeducation	4.44 (3.47)	2.99 (2.49)	2.85 (3.18)	2.56 (2.91)
MAIA[4]				
STEP	2.74 (.60)	2.90 (.58)	2.89 (.66)	2.96 (.62)
MBCT Plus Psychoeducation	2.60 (.72)	3.15 (.57)	3.08 (.63)	3.19 (.63)
SCS Self-compassion[5]				
STEP	3.07 (.79)	3.22 (.69)	3.21 (.69)	3.36 (.71)
MBCT Plus Psychoeducation	3.27 (.81)	3.63 (.71)	3.55 (.73)	3.65 (.76)
SCS Self-criticism[5]				
STEP	3.20 (.83)	3.12 (.89)	3.00 (.91)	2.91 (.84)
MBCT Plus Psychoeducation	3.13 (.93)	2.65 (.87)	2.63 (.87)	2.58 (.89)
FFMQ[6]				
STEP	126.02 (17.95)	126.19 (17.67)	127.66 (19.16)	130.89 (19.35)
MBCT Plus Psychoeducation	123.76 (18.02)	134.47 (17.49)	131.92 (17.79)	138.06 (18.27)

Possible range of scores: [1]0 to 51; [2]0 to 52; [3]0 to 28; [4]0 to 5; [5]1 to 5; [6]39 to 195. STEP = supportive sex education and therapy group; MBCT = mindfulness-based cognitive therapy plus psychoeducation group; SIDI = Sexual Interest and Desire Inventory; FSDS-R = Female Sexual Distress Scale-Revised; HAMD = Hamilton Depression Rating Scale; MAIA = Multidimensional Assessment of Interoceptive Awareness; SCS Self-compassion = Self-Compassion subscale of the SCS; SCS Self-criticism = Self-criticism subscale of the SCS; FFMQ = Five Facet Mindfulness Questionnaire.

Table 3. Test of moderated mediation.

		Path *b* moderated by treatment		
Outcomes (Y) Mediators (M)	Path *a* moderated by treatment		SIDI	FSDS-R
	B (SE)			
HAMD				
Time ➔ M	−.36 (.09)***	M ➔ Y	−.57 (.16)***	.78 (.15)***
Time x treatment ➔ M	−0.33(.19)†	M x treatment ➔ Y	−.34 (.28)	.48 (.25)†
MAIA				
Time ➔ M	.11 (.01)***	M ➔ Y	9,31 (1.06)***	−9.69 (.94)***
Time x treatment ➔ M	.11 (.03) ***	M x treatment ➔ Y	2.01 (2.01)	−2.35 (1.77)
SCS Self-compassion				
Time ➔ M	.08 (.01)***	M ➔ Y	4.76 (1.03) ***	−6.45 (.91)***
Time x treatment ➔ M	.02 (.03)	M x treatment ➔ Y	4.07 (1.76)*	−2.60 (1.60)
SCS Self-criticism				
Time ➔ M	−.10 (.02)***	M ➔ Y	−4.46 (.91)***	5.59 (.82)***
Time x treatment ➔ M	−.09(.03)**	M x treatment ➔ Y	−1.24 (1.65)	.03 (1.49)
FFMQ				
Time ➔ M	2.38 (.37)***	M ➔ Y	.21 (.04) ***	−.25 (.04)***
Time x treatment ➔ M	2,61 (.74)***	M x treatment ➔ Y	.13 (.07)†	−.08 (.07)

SIDI = Sexual Interest and Desire Inventory; FSDS-R = Female Sexual Distress Scale-Revised; HAMD = Hamilton Depression Rating Scale; MAIA = Multidimensional Assessment of Interoceptive Awareness; SCS Self-compassion = Self-Compassion subscale of the SCS; SCS Self-criticism = Self-criticism subscale of the SCS; FFMQ = Five Facet Mindfulness Questionnaire.
*$p < .05$.**$p < .01$, ***$p < .001$, † $.05 < p < .10$.

for both outcomes: they predicted changes in desire and arousal, and distress only for participants in MBCT plus psychoeducation.

Figure 2 presents the summary of mediation effects. The moderating effect of type of treatment on mediation was present in seven out of 10 tested models. In four of those cases (self-compassion and mindfulness mediating improvements in desire and arousal, and mindfulness mediating improvements in sexual distress), moderation by treatment was due to the mediation taking place for participants in the MBCT plus psychoeducation arm but not for those in the STEP condition. For the other three cases of moderated mediation (interoceptive awareness mediating improvements in desire and arousal, and distress, and self-criticism mediating improvement in distress), the mediation effect was present in both groups but was three times as strong for those in the MBCT plus psychoeducation arm.

Overall, the proportion of total effect accounted for by significant indirect effects ranged from 5% (changes in self-compassion mediating improvements in sexual distress for STEP participants) to 31% (changes in interoceptive awareness mediating improvements in sexual distress for MBCT plus psychoeducation participants).

Table 4. Bootstrap results for moderated mediation indirect effect conditional on treatment group.

	Sexual Desire and Arousal		Sexual Distress	
Mediators	Indirect effect (95% CI)	% of Total effect explained by indirect effect	Indirect effect (95% CI)	% of Total effect explained by indirect effect
HAMD				
STEP	.03 (−.06, .19)	1%	−.06 (−.19, .05)	2%
MBCT Plus Psychoeducation	.25 (−.03, .61)	7%	−.43 **(−.90, −.10)**	12%
MAIA				
STEP	.28 **(.02, .67)**	8%	−.30 **(−.69, −.04)**	10%
MBCT Plus Psychoeducation	1.06 **(.63, 1.57)**	26%	−1.20 **(−1.76, −.74)**	31%
SCS Self-compassion				
STEP	−.01 (−.33, .27)	0.3%	−.18 **(−.38, −.03)**	5%
MBCT Plus Psychoeducation	.34 **(.06, .71)**	9%	−.48 **(−.93, −.13)**	13%
SCS Self-criticism				
STEP	.07 (−.15, .32)	2%	−.18 **(−.35, −.04)**	5%
MBCT Plus Psychoeducation	.39 (−.01, .91)	10%	−.53 **(−1.10, −.08)**	15%
FFMQ				
STEP	.01 (−.21, .22)	0.3%	−.11 (−.34, .03)	3%
MBCT Plus Psychoeducation	.55 **(.06, 1.18)**	14%	−.68 **(−1.21, −.26)**	18%

CIs not including zeros are in bold. STEP = supportive sex education and therapy group; MBCT = mindfulness-based cognitive therapy plus psychoeducation group; SIDI = Sexual Interest and Desire Inventory; FSDS-R = Female Sexual Distress Scale-Revised; HAMD = Hamilton Depression Rating Scale; MAIA = Multidimensional Assessment of Interoceptive Awareness; SCS Self-compassion = Self-Compassion subscale of the SCS; SCS Self-criticism = Self-criticism subscale of the SCS; FFMQ = Five Facet Mindfulness Questionnaire.

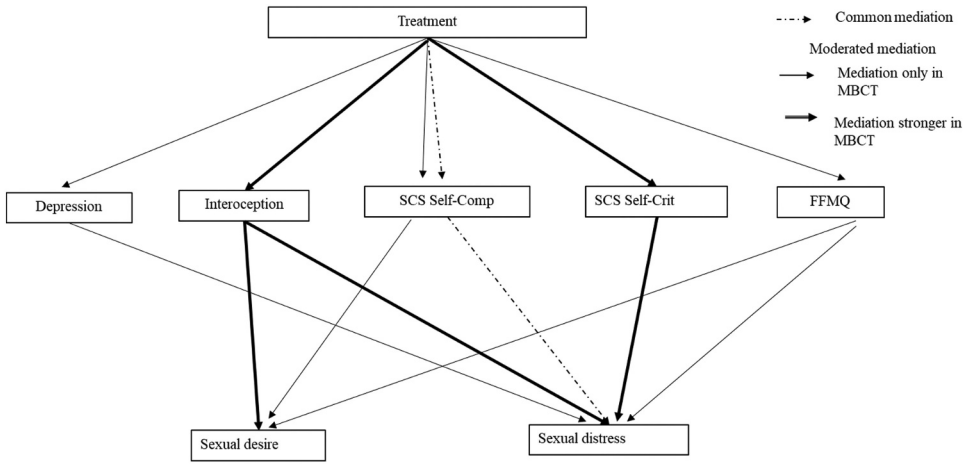

Figure 2. Moderated and common mediation effects. Moderated effects only present in MBCT plus psychoeducation treatment are marked with thin solid arrows, moderated effects stronger in MBCT plus psychoeducation than STEP are marked with thick solid arrows and common effects are marked with dashed arrows. STEP = supportive sex education and therapy group; MBCT = mindfulness-based cognitive therapy plus psychoeducation group.

Moderation of Treatment Effects

Neither of the two items measuring treatment expectations (i.e., perceiving treatment as logical, and believing they would improve; Table 1) moderated effects of treatment on desire and arousal or sexual distress. The degree to which participants perceived treatment as logical did not impact the treatment effects within groups [three-way interaction of treatment credibility by time by group resulted in F (3, 348.5) = 0.53, p = .661 for sexual desire and arousal, and F (3, 357.5) = 0.60, p = .617 for sexual distress] or across groups [two-way interaction of treatment credibility by time resulted in F (3, 348.5) = 1.54, p = .204 for sexual desire and arousal, and F (3, 357.5) = 0.37, p = .776 for sexual distress]. Similar non-significant results were found for the degree to which participants believed the treatment will improve their desire and arousal. The three-way interaction produced F (3, 348.1) = 0.84, p = .475 when predicting improvements in sexual desire and arousal, and F (3, 357.2) = 0.68, p = .565 predicting sexual distress, while the two-way interaction resulted in F (3, 348.1) = 0.62, p = .601 for sexual desire and arousal, and F (3, 357.2) = 1.32, p = .268 for sexual distress.

Discussion

The goal of this study was to evaluate mediators and moderators of improvement in sexual desire and arousal, and sexual distress, from baseline to 12-months after treatment by MBCT plus psychoeducation adapted to women with SIAD. The mechanisms accounting for MBCT plus psychoeducation's efficacy, above and beyond a supportive sex education treatment alone (STEP; which did not contain any elements of mindfulness), represent the novelty of the present study. To our knowledge, this is the first study to focus on mediators of change in women with SIAD using MBCT plus psychoeducation and the comparison arm of psychoeducation without mindfulness, in a well-powered and randomized study design.

Mediators of Change Common to Both MBCT Plus Psychoeducation and STEP

Apart from depression, we predicted that each of the other mediators would be specific to the MBCT plus psychoeducation arm only. However, we did find that improvements in self-compassion mediated improvements in sexual distress after both MBCT plus psychoeducation and STEP. This was the only mediator and outcome found to be common to both MBCT plus psychoeducation and STEP, and these effects were specific to sexual distress and not sexual desire and arousal. The STEP group delivered information on the prevalence and causes of sexual difficulties and provided a model to help participants consider the major contributors to their low desire (Basson, 2001). It is possible that in learning about the (high) prevalence of sexual concerns, participants felt validated and their concerns were normalized, and this may have led them to be more compassionate to themselves about their concerns after STEP, and ultimately, underlie some of the improvement in their distress as a result of feeling validated. Although there is no direct evidence for this in the sex research literature, there is evidence that psychoeducational programs can elicit self-compassion (Talbot et al., 2017). Consistent with our prediction that improvements in self-compassion would mediate improvements in distress after MBCT, self-compassion mediated this same outcome in women with provoked vestibulodynia (Brotto et al., 2020). Given that the MBCT plus psychoeducation group brought more explicit attention to self-compassion during the inquiries that followed each mindfulness practice, and group participants discussed the potential for their increasing self-compassion to help them manage the distress associated with their sexual concerns, it is not surprising that self-compassion also mediated this outcome in the MBCT plus psychoeducation group.

Mediators of Change in the MBCT Plus Psychoeducation Arm Only

All other mediators were specific to improvements after MBCT plus psychoeducation, not STEP, and illustrate the value added when mindfulness skills are combined with basic psychoeducation. For example, improvements in depressive symptoms mediated improvements in sexual distress only for those in the MBCT plus psychoeducation group. This finding aligns with systematic reviews, which find that improvements in depression mediate improvements in clinical outcomes after mindfulness (Alsubaie et al., 2017; Gu et al., 2015; Maddock & Blair, 2021; van der Velden et al., 2015). An earlier study found this same MBCT plus psychoeducation intervention to significantly reduce ruminative thoughts about sex (Brotto et al., 2021), which may be explained by the current finding of reduced depressive symptoms as a mechanism of action. Anecdotal feedback from study participants indeed was that mindfulness instilled feelings of hope and challenged their depressive thoughts, thereby improving symptoms of major depression, which then targeted their sexual distress. Of note, improvements in depression did not mediate improvements in sexual desire and arousal in the MBCT plus psychoeducation group, suggesting that there may be other mediators of change contributing to changes in desire and arousal, and improvements in depression are only linked to improvements in sexual distress.

As predicted, changes in interoceptive awareness also mediated improvements in sexual desire and arousal, and in sexual distress in both groups, but to a significantly greater degree in the MBCT plus psychoeducation group. Participants practiced the body scan regularly throughout the eight weeks of the MBCT plus psychoeducation group and learned to notice sensations in their body with receptivity, acceptance and equanimity. Interoceptive awareness is largely based upon the skill of noticing internal sensations, and as participants further increased their interoceptive skills, they began to incorporate this skill into sexual encounters – both alone and with a partner. Our findings suggest that the very practice of enhancing awareness of internal sensations may have translated into improved ability to detect sexual sensations (consistent with the findings of Silverstein et al., 2011) and therefore increased sexual desire and arousal; the receptivity and equanimity toward interoceptive sensations trained during body scanning may have contributed to reduced sexual distress.

The IMM (Singer & Toates, 1987; Toates, 2009) states that sexual arousal triggers sexual desire, which explains how increased interoceptive awareness to sexual arousal and other body sensations mediated the improvements in our primary outcome. Our findings align with previous research using the same intervention (Paterson et al., 2017) but using a methodologically rigorous study design, and including a comparison arm of the psychoeducational elements already contained in the MBCT plus psychoeducation arm to control for education. Moreover, that interoceptive awareness also mediated improvements in sexual distress suggests that enhancing awareness of body sensations with equanimity, including sexual sensations, likely reduced distress among those participants who may have believed that their sexual sensations were gone. It is well established that the development of interoceptive awareness capacities leads to improved sensory awareness and reduced distress (Price & Hooven, 2018); however, this is the first time it has been applied to improvements in sexual distress.

Improvements in self-compassion mediated improvements in sexual desire and arousal for the MBCT plus psychoeducation group but not for the STEP group. A similar MBCT intervention led to improvements in sexual function that were also mediated by changes in self-compassion (Paterson et al., 2017). Self-compassion is, in part, defined by the willingness to alleviate suffering with kindness (Neff, 2003). As sexual desire is conceptualized as responsive to arousal and to motivations for sex (Basson, 2001), it is possible that the kindness toward oneself that was cultivated throughout the MBCT plus psychoeducation arm may have led participants to be open to experiencing and sensing this responsive desire. In time-lagged analyses, changes in mindfulness lead to changes in self-compassion, which then contributed directly to improvements in mood following mindfulness-based stress reduction (Evans et al., 2018). There is a similar finding when measuring anxiety outcomes in that mindfulness directly leads to changes in self-compassion, which then reduce anxiety

symptoms, and not the other way around in terms of causation (Bergen-Cico & Cheon, 2014).

Self-criticism is a construct that is orthogonal to self-compassion and includes self-judgment, isolation, and over-identification (Neff, 2016). In our study, decreases in self-criticism mediated greater reductions in sexual distress in both the MBCT plus psychoeducation and STEP groups, but to a far greater extent after MBCT plus psychoeducation. The lack of a mediating effect on sexual desire and arousal is not surprising, given evidence that decreases in "uncompassionate" behaviors (such as self-criticism) are more likely to reduce negative mind-states (like sexual distress) rather than elicit positive responses (like desire) (Neff, 2016). Though the mediating effects of self-criticism on sexual distress were stronger in the MBCT plus psychoeducation arm, this mediation was still significant in the STEP arm, suggesting that education alone elicited changes in participants' self-criticisms, which then contributed to reductions in their sexual distress. It is possible that in providing accurate information about sexual health and desire, this led to participants feeling validated and thus less likely to be self-critical, translating into less distress. Since in the MBCT plus psychoeducation arm participants practiced noticing and acceptance of self-critical thoughts, it is likely that this more explicit targeting of self-criticism led to it being a stronger mediator of reduced distress in the MBCT plus psychoeducation arm.

The final potential mediator examined was mindfulness, and we found that it significantly mediated improvements in both sexual desire and arousal, and sexual distress, only in the MBCT plus psychoeducation arm. This finding is consistent with published systematic reviews showing changes in mindfulness to be a key mediator of improvements in primary outcomes (Alsubaie et al., 2017; Gu et al., 2015) in studies targeting depression and anxiety. Compared to a cognitive behavioral therapy intervention, a different study demonstrated the benefits of group mindfulness on genital pain that were mediated by improvements in mindfulness (Brotto et al., 2020), and an uncontrolled study of group mindfulness in women with SIAD also found mindfulness to mediate improvements in overall sexual function (Paterson et al., 2017). The lack of a mediating effect of mindfulness in the STEP arm is consistent with predictions given that this intervention did not attempt to cultivate mindfulness skills.

Contrary to predictions, we did not find that expectations for improvement with treatment moderated improvements for either sexual desire and arousal, or sexual distress, for either treatment arm. The average level of baseline expectations for treatment efficacy provided by participants was, on average, from moderate-to-high treatment outcome expectations with similarly wide ranges across the two arms. Despite this, treatment expectations did not moderate outcomes on desire and arousal or distress. This is comparable to an uncontrolled study of group mindfulness for SIAD, which also found no effect of baseline treatment expectations on sexual desire or distress (Paterson et al., 2017) but is different from a study showing that high expectations for improvement lead to greater improvements in genital pain following mindfulness therapy (Brotto et al., 2020).

Value Added of Mindfulness Above and Beyond Psychoeducation

As reviewed earlier, MBCT plus psychoeducation was more effective than supportive sex education for the primary endpoint of sex-related distress, but also for rumination and relationship satisfaction (Brotto et al., 2021). However, supportive sex education was as effective as MBCT plus psychoeducation for improving sexual desire. While the current paper found significant added value of mindfulness above and beyond sex education with regard to a number of specific mediators underlying MBCT plus psychoeducation but not STEP, we also found that STEP led to improved desire and arousal mediated by changes in interoceptive awareness. Here we speculate on how this might have transpired, particularly since the STEP group had minimal training in body awareness, and instead, focused on providing education about the circular sexual response cycle (Basson, 2001), which emphasized the responsive nature of sexual desire when participants notice and attend to sexual arousal. It is possible that this information, alone, was sufficient to encourage participants to cultivate greater interoceptive awareness as a means of paying attention to sexual triggers, and to the arousal-to-desire pathway. Participants in this arm were also introduced to sensate focus, and this might have contributed to changes in interoception that mediated outcomes given that the exercise involves having the receiver of touch pay attention to their internal sensations (Weiner & Avery-Clark, 2014).

The Importance of Examining Mediators in Psychological Treatment Outcome Studies for Sexual Dysfunction

Pyke and Clayton (2015) argued that there was no "fully sound proof that psychological treatments are effective for HSDD [hypoactive sexual desire disorder], whether CBT, or mindfulness training" (p. 2457), and in part attributed this to the fact that published studies had not systematically measured expectations for improvement. A randomized clinical trial demonstrating the short-term and sustained benefits of MBCT plus psychoeducation on sexual desire, sex-related distress, relationship satisfaction, and rumination (Brotto et al., 2021) challenges their first criticism (i.e., that mindfulness does not work), and the present findings (i.e., that expectations for improvement did not moderate outcomes) challenge their second criticism. Nonetheless, given how strong the placebo response is in pharmaceutical trials of women's sexual problems (up to 40% of women in the placebo group report a positive response according to a review by Bradford, 2013), it remains important that expectations for improvement be included in all treatment outcome studies for sexual concerns, whether pharmacological or psychological. Taken together, our findings suggest that the benefits of mindfulness on sexual desire and arousal, and for sexual distress are likely due to the therapeutic elements of that intervention, as opposed to being due to participants just *believing* that the treatment might help them.

Limitations and Strengths

There are a few limitations to the study that need to be considered. First, participants were highly educated, and able to commute to a medical center in a major metropolitan city, which suggests that they were able to overcome barriers that often prevent women from seeking care for sexual health concerns (Shifren et al., 2009). That 80% of the participants were White also significantly limits the generalizability of the findings to Indigenous, Black, and other Persons of Color.

That some mediators (namely, depressive symptoms and mindfulness) of symptom improvement were significant only in the MBCT plus psychoeducation arm and not in the STEP arm may relate to the fact that participants engaged more with the materials in the MBCT plus psychoeducation arm, being asked to complete daily mindfulness practices. This may have resulted in a greater "dose" of treatment with MBCT plus psychoeducation than with STEP and allowed some mediators to exert a greater effect in that arm. However, a higher "dose" of mindfulness treatment does not necessarily lead to greater symptom improvement when depression and anxiety are the primary outcomes (Strohmaier, 2020).

Another limitation pertains to the selected number of mediators examined. We identified five potential mediators in *a priori* analyses at pre-registration, but it is likely that there may have been other mediators found to underlie symptom improvement in either or both treatment arms which we did not study. The mediators examined focused on the mindfulness plus psychoeducation intervention, and we did not include mediators focused on supportive sex education (e.g., information learned, degree of felt support, and group cohesion). Degree of partner involvement and level of anxiety may have both acted as mediators of treatment outcome, but neither were assessed in this study. Additionally, repetitive negative thinking, aversion and cognitive and emotional reactivity have been found to be significant mediators in clinical trials of mindfulness on outcomes pertaining to depression and anxiety (Gu et al., 2015; Maddock & Blair, 2021) that we did not study.

Although we cannot rule out allegiance effects, in which the group facilitators may have had more loyalty to one treatment arm over another, the finding that facilitators were highly compliant with the structured treatment manuals in both arms (see Brotto et al., 2021) helps to alleviate this possible concern.

Finally, we are limited in our claims about causal links in the mediation processes we tested because we did not establish temporal precedence between changes in the mediators and changes in the outcomes (MacKinnon & MacKinnon, 2008). Thus, our mediation findings are still based on correlative associations between mediator and outcome changes.

Despite these limitations, our study had numerous strengths. To the best of our knowledge, this is the first study exploring mediators and a moderator of sexual desire and arousal, and sexual distress in the context of a randomized trial evaluating mindfulness plus psychoeducation for SIAD. We were able to control for the psychoeducational contents of the MBCT arm by examining their effects (combined with supportive expressive therapy skills) in the STEP arm. While not a perfectly comparable control group, the inclusion of the STEP group addresses the critical need to ensure that comparison treatment arms are of the same duration and length as the intervention arm (Pyke & Clayton, 2015). The identification of putative mediators was done *a priori*, and in alignment with the IMM (Singer & Toates, 1987; Toates, 2009). Though there have been past studies exploring mediators in treatment outcome studies for low desire, the present study was well powered to detect significance both for the primary outcomes and also for the analysis of mediators and moderators. Another strength is that the mediators were measured repeatedly after the onset of treatment, allowing us to test the mediation using change scores in both the mediators and the outcomes. Therefore, even though the causal claims are limited because we did not establish temporal precedence between mediator and outcome changes, we have taken one important step toward exploring the dynamic, longitudinal mechanisms underlying treatment-related improvements in sexual functioning.

Clinical Implications

The current findings point to the important role of changes in self-compassion, depressive symptoms, interoception, self-criticism, and mindfulness as being mediators of change in sexual desire and arousal, and sexual distress following MBCT plus psychoeducation treatment. The only mediator found to equally account for improvements in sexual distress in both arms was self-compassion, suggesting that education alone can lead to improvements in self-compassion that account for improvements in sexual distress. This is notable for non-specialists who may be offering sex education as the sole (or primary) treatment to individuals seeking treatment for SIAD. On the other hand, that the other mediators were specific to the MBCT plus psychoeducation group suggests that mindfulness treatment, specifically, leads to improvements in sexual desire and arousal, and sexual distress, that are (in part) attributable to changes in self-compassion, depression, interoception, self-criticism, and mindfulness. Though some of these mediators account for improvements in outcomes in both arms, changes in depressive symptoms and improvements in mindfulness were specific mediators to the MBCT plus psychoeducation arm only. These findings are important for health care providers who may engage treatment seekers with an interest in the underlying "why" of how mindfulness-based treatment may work to improve their symptoms.

Expectations for improvement with treatment and degree to which participants felt that the treatment was logical did not predict outcomes on sexual desire and arousal or distress, for either arm. The implication of this finding is that we might predict both treatments to be equally effective regardless of how invested a person is in the treatment or how skeptical they are about its potential efficacy. In other words, a person's expectations for improvement bear no relevance on how much improvement they experience in sexual desire and arousal, and sexual distress. That said, expectations for improvement were relatively high in both groups, which likely contributed to the sizable response to both treatments.

Conclusion

The current study contributes novel data on the mechanisms underlying MBCT plus psychoeducation (namely, improvements in depressive symptoms, interoception, self-criticism, and mindfulness) versus supportive sex education for the treatment of individuals with SIAD. Whereas self-compassion was a common mediator in both groups to improvements in sexual distress, all other mediators examined were stronger for the MBCT plus psychoeducation arm compared to the supportive sex education arm. Interestingly, treatment expectancy did not moderate improvements in sexual desire and arousal, or distress, contrary to predictions. These findings have implications for theoretical models accounting for low desire in women, like the IMM, and may point to future treatment targets that leverage these mediators as underlying mechanisms of change.

Disclosure statement

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