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ORIGINAL PAPER

Postpartum Outcomes and Formal Mindfulness Practice in Mindfulness-Based Cognitive Therapy for Perinatal Women

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Abstract Anxiety is common during pregnancy and associated with poorer outcomes for mother and child. Our single-arm pilot study of an 8-week mindfulness-based cognitive therapy (MBCT) intervention for pregnant women with elevated anxiety showed significant pre- to post-intervention improvements in anxiety, depression, worry, mindfulness, and self-compassion. It remains unclear whether these improvements are maintained postpartum and whether amount of formal mindfulness practice is correlated with outcomes. The current study examined whether (1) improvements in psychosocial outcomes were maintained 3 months postpartum; (2) women were adherent to formal practice recommendations; and (3) amount of mindfulness practice was correlated with outcomes. Twenty-three pregnant women (M_{age} = 33.5, SD = 4.40; 75% White; 71% with generalized anxiety disorder) completed home practice logs throughout the intervention, and self-report measures before and after the intervention and 3 months postpartum. Results indicated that previously reported post-intervention improvements in anxiety, worry, mindfulness, and self-compassion were maintained postpartum (p's < .05), and reductions in depression further improved (p < .001). Participants were generally adherent to mindfulness practice recommendations during the intervention (54–80% weekly adherence; M = 17.31 total practice hours [SD = 7.45]), and many continued practicing 1 week post-intervention (91%) and postpartum (55%). Mindfulness practice during the intervention was not significantly correlated with any outcome at post-intervention or postpartum. Mindfulness practice postpartum was only marginally related to improved worry postpartum (p = .05). MBCT may be associated with maintained improvements in psychosocial outcomes for women during pregnancy and postpartum, but the role of mindfulness practice is unclear. Research using larger samples and randomized controlled designs is needed.

Keywords Mindfulness · MBCT · Pregnancy · Anxiety · Mindfulness practice

Introduction

Anxiety is common among pregnant and postpartum women (Faisal-Cury and Menezes 2007; Goodman and Tyer-Viola 2010; Heron et al. 2004; Lee et al. 2007). A substantial number of pregnant women meet diagnostic criteria for an anxiety disorder during pregnancy or in the first year after delivery (for reviews see Goodman et al. 2014b, 2016), and anxiety might be more common than depression among pregnant women (Fairborther et al. 2016). Maternal anxiety during pregnancy is associated with poorer outcomes for mother and child, including greater pregnancy symptoms, more medical visits, obstetric complications, shorter gestation, greater child emotional-behavioral problems, and increased risk for maternal postpartum depression (Alder et al. 2007; Glover and O'Connor 2006; Goodman et al. 2014a, b; O'Connor et al. 2002; Talge et al. 2007; Van den Bergh et al. 2008). Fewer

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studies have examined outcomes associated with postpartum anxiety, yet maternal postpartum anxiety may be associated with negative effects on mother-infant relationship factors (e.g., maternal parenting behaviors, mother-infant interaction, bonding) and infant outcomes (e.g., crying, distress to novelty, social responsiveness, and physiological responses), which may increase risk for child behavioral problems and psychopathology (Glasheen et al. 2010; Goodman et al. 2016; Stein et al. 2014).

Women are often reluctant to use pharmacological treatments during pregnancy due to potential fetal exposure risks (Arch 2014; Battle et al. 2013; Goodman 2009), highlighting the need for evidence-based non-pharmacological interventions to reduce perinatal anxiety. Mindfulness-based interventions (MBIs) are one non-pharmacological approach that may be efficacious for improving mental health outcomes during pregnancy and postpartum. Mindfulness involves the self-regulation of attention toward present moment experiences with an attitude of openness and curiosity (Bishop et al. 2004). MBIs teach individuals to notice internal experiences mindfully in order to reduce suffering and promote healthy behavioral responses (Sears et al. 2011). A systematic review and meta-analysis of 17 trials of perinatal MBI's found significant small-medium improvements in anxiety, depression, stress, and mindfulness from before to after the intervention but no significant differences when compared to active or wait-list control groups (Taylor et al. 2016). Several studies have included postpartum follow-up assessments and most (Byrne et al. 2014; Dimidjian et al. 2015, 2016; Fisher et al. 2012; Perez-Blasco et al. 2013), though not all (Guardino et al. 2014; Vieten and Astin 2008) showed sustained improvements. One possible explanation for the limited effects of MBI's on perinatal outcomes is that participants did not engage in a sufficient amount of mindfulness practice (Taylor et al. 2016).

Mindfulness practice is a key component of MBIs. Mindfulness practices include within session and between-session home practices of formal (e.g., mindfulness meditation, mindful yoga, body scan) and informal practices (e.g., bringing mindfulness to everyday activities such as walking or eating). Although mindfulness practice is considered a critical mechanistic component of MBIs, the relationship between amount of practice and MBI outcomes is mixed (Vettese et al. 2009). Among pregnant women in MBIs, only a few studies have described home practice adherence, finding that pregnant women might practice mindfulness less frequently than demonstrated in other populations (Byrne et al. 2014; Dimidjian et al. 2016; Gambrel and Piercy 2015; Guardino et al. 2014; Taylor et al. 2016; Woolhouse et al. 2014), and we are not aware of any research that has examined the relationship between mindfulness home practice and treatment outcomes in perinatal women. Understanding the role of home practice, particularly formal (vs. informal) mindfulness practices that require taking time out of the day, could help improve treatment delivery and feasibility for pregnant women and might further improve the efficacy of perinatal mindfulness interventions (Taylor et al. 2016).

The Coping with Anxiety through Living Mindfully (CALM) Pregnancy intervention is an application of mindfulness-based cognitive therapy (MBCT) adapted specifically to pregnant women with anxiety (Goodman et al. 2014a, b). MBCT is an 8-week evidence-based group MBI, originally developed for prevention of depression relapse in patients with previous major depressive episodes. MBCT combines traditional cognitive-behavioral therapy with consistent mindfulness training in weekly 2-hour sessions with up to 60 min of daily home practice (Segal et al. 2012). In a single-arm open-label pilot study, 24 pregnant women with generalized anxiety disorder (GAD) or significant symptoms of generalized anxiety were enrolled and participated in the 8-week CALM Pregnancy intervention (Goodman et al. 2014a). Twenty-three participants completed the intervention with high attendance and good adherence to formal home practice across the full intervention (i.e., an average of four out of six prescribed 30-min practices per week). Completers showed statistically and clinically significant improvements in anxiety, worry, and depression, and significant increases in self-compassion and mindfulness at 1 week post-intervention. Of the 17 participants who met GAD criteria at baseline, only one continued to meet criteria post-intervention. Additionally, the two participants who also met criteria for MDD at baseline were no longer depressed post-intervention.

The current study aims to extend the original CALM Pregnancy study to explore whether effects were maintained postpartum, whether women were adherent to formal practice recommendations, and whether amount of formal mindfulness practice was related to outcomes. Specifically, the aims of the current study were to (1) examine whether post-intervention improvements in the main study outcomes (anxiety, worry, depression, mindfulness, and self-compassion) were maintained at 3 months postpartum; (2) describe the recommendations and amount of formal mindfulness practice actually completed each week of the 8-week intervention, at 1 week post-intervention, and at 3 months postpartum; (3) explore the longitudinal relationship between amount of formal mindfulness practice during the intervention and outcomes at post-intervention and postpartum; and (4) explore the cross-sectional relationship between continued formal practice and outcomes during the postpartum phase. We compare outcomes to established clinical cut-offs or normative means on each measure to help characterize the clinical significance of the results. We hypothesized that all outcomes would show maintained improvements from post-

intervention into the postpartum period, and that greater formal practice would be correlated with better outcomes at post-intervention and postpartum.

Method

Participants

Participants were 24 pregnant women (M_{age} = 33.5, SD = 4.40; 75% White). Most participants (75%) were pregnant with their first child, and women were pregnant for an average of 15.54 weeks at baseline (SD = 5.83). Seventy-one percent met diagnostic criteria for GAD at baseline. The remaining seven participants met study inclusion criteria due to high levels of worry and/or generalized anxiety symptoms (see Goodman et al. 2014a for details).

Procedure

Pregnant women were recruited from a large urban teaching hospital and obstetric clinics in Boston (see Goodman et al. 2014a for details). Eligible women participated in the 8-week adapted MBCT intervention, CALM Pregnancy. Participants completed self-report measures of anxiety, worry, depression, mindfulness, and self-compassion before the intervention, 1 week after participating in the intervention, and at 3 months postpartum. Because participants completed the follow-up questionnaires at 3 months postpartum, the amount of time since completion of the intervention varied across participants depending on where they were in their pregnancy when enrolled in the intervention. Session attendance was recorded and home practice logs were completed by participants and collected weekly during the intervention phase of the study. Two groups of participants completed the intervention in Fall 2012 (n = 15), and a third group (n = 9) in Winter 2013. For the fall groups, because one of the sessions fell on a holiday, the week 5 session was postponed for 1 week; these participants therefore completed the home practice log for 2 weeks between sessions 5 and 6. For the winter group, sessions were held once per week for 8 consecutive weeks. Participants were given a packet of questionnaires to complete 1 week after the intervention and then were mailed a similar packet at 3 months postpartum to collect follow-up outcome data and continued home practice data.

CALM Pregnancy Intervention Similar to the standard MBCT protocol, CALM Pregnancy was focused on training in formal mindfulness and informal mindfulness practices. Sessions included didactic presentations, group exercises, formal meditation practices, and leader-facilitated group inquiry and discussion. Formal practices included the body scan, mindful yoga, and sitting meditation. Informal mindfulness practices included mindfulness of everyday activities such as mindful eating and mindful walking. The intervention also incorporated the 3-min breathing space and cognitive approaches for developing alternative ways of responding to stress and anxiety symptoms. Approximately 30 min of daily home practice of formal and informal mindfulness practices was assigned and encouraged between classes. MP3s of guided meditations were provided for formal practice, and relevant readings were provided. In addition, for five of the weeks, participants were encouraged to also practice the 3-min breathing space three times per day. During the last 3 weeks of the intervention, they were encouraged to also utilize the 3-min breathing space "whenever they noticed unpleasant thoughts or feelings". The parent paper provides a further outline of intervention components (Goodman et al. 2014a).

Measures

Beck Anxiety Inventory The Beck Anxiety Inventory (BAI) (Beck and Steer 1990) is a well-validated 21-item measure of anxiety symptoms. Each item assesses the level of distress associated with physical and cognitive anxiety symptoms (e.g., numbness or tingling, nervous) on a 4-point scale ranging from 0 (not at all) to 3 (severe) with higher scores indicating greater anxiety symptoms. It discriminates effectively from depression symptoms and demonstrates good psychometric properties (Beck et al. 1988a, b). Internal consistency was good in the current sample (α = .82 post-intervention and .82 at follow-up). We are not aware of BAI norms in pregnant women; based on GAD samples, a clinical cut-off $\leq$ 10 was used (M = 10.3; SD = 7.5; Leyfer et al. 2006).

Penn State Worry Questionnaire The Penn State Worry Questionnaire (PSWQ) (Meyer et al. 1990) is a widely used 16-item self-report questionnaire designed to assess the generality, excessiveness, and uncontrollability of worry. Higher scores represent a greater degree of worry. In this sample, the internal consistency as assessed by Cronbach's alpha was 0.83 at post-intervention and .71 at follow-up. We are not aware of PSQW norms in pregnant women; based on GAD samples, a cut-off score of 65 was used (M = 68.11, SD = 7.33; Fresco et al. 2003).

Beck Depression Inventory—Second Edition The Beck Depression Inventory (BDI)-II (Beck et al. 1996) is a 21-item measure of depressive symptoms over the past 2 weeks. Symptoms are based on DSM-IV criteria and include sadness, anhedonia, and guilt. Items are measured on a 4-point scale with higher scores indicating greater symptoms. The BDI is a well-validated measure with established validity and reliability (Beck et al. 1988a, b). Cronbach's alpha in the current study was .91 at post-intervention and .89 at follow-up. Based on

validation studies in pregnant women, a clinical cut-off of 13 was used (Ji et al. 2011).

Mindful Attention Awareness Scale The Mindful Attention Awareness Scale (MAAS) (Brown and Ryan 2003) is a 15-item measure of dispositional mindfulness. Each item assesses a lack of awareness in everyday life on a scale from 1 (almost always) to 6 (almost never) such that higher scores indicate greater mindfulness (e.g., "I rush through activities without really being attentive to them"). It shows good reliability and validity (Brown and Ryan 2003). Internal consistency was good at post-intervention (α = .94) and follow-up (a = .93). As we are not aware of norms for pregnant women or anxiety samples, scores were compared to the normative mean in a large sample of healthy young adults (M = 4.00, SD = .85; MacKillop and Anderson 2007).

Self-Compassion Scale The Self-Compassion Scale (SCS) (Neff 2003) assesses self-compassion in terms of three domains: (1) self-kindness rather than self-judgment, (2) common humanity rather than isolation, and (3) mindfulness rather than over-identification. The short-form used in the current study contains 12 items rated on a 5-point scale from 1 (almost never) to 5 (almost always), with higher scores indicating greater self-compassion (e.g., "I try to see my failings as part of the human condition"). It shows good psychometric properties, and internal consistency was good in the current study (α = .85 post-intervention and .92 at follow-up). We are not aware of norms for pregnant or anxious samples and thus compare scores to mean scores from a large sample of healthy young adults (M = 36.00, SD = 7.33; Raes et al. 2011).

Home Practice Throughout the intervention phase, participants were asked to record their daily formal mindfulness practice on a home practice log, which they turn in at each subsequent session. The log varied each week to reflect the specific recommendations for that week. Each log listed the 30-min formal mindfulness practice recommendations for each day of the week (e.g., mindfulness meditation, mindful yoga, and/or mindful body scan) and asked participants to circle yes or no to indicate whether they completed the formal mindfulness practice each day. For weeks in which the 3-min breathing space exercise was also recommended, participants indicated the number of times they practiced that each day.

At 1 week post-intervention and at 3 months postpartum, participants were asked to indicate yes or no to the question, "Are you still meditating?" Those who answered yes were asked "How regularly?" (every day or almost every day, 3 times per week or more, less than 3 times per week, less than once per week), "How long do you usually meditate when you do?" (30 min or longer, between 15 and 30 min, less than 15 min), and "What technique do you use the most?" (sitting with awareness of breathing, sitting with awareness of breathing and other sensations, boy scan, 3-min breathing space). Participants were also asked to indicate yes or no to the question, "Do you continue to do yoga exercises that you learned in the CALM Pregnancy program?". If yes, participants were asked "how regularly?" (every day or almost every day, 3 times per week or more, less than 3 times per week, less than once per week). Data on informal practice were not collected.

Data Analyses

Data were analyzed for 23 women, as one woman withdrew from the study after the second session. All 23 treatment completers completed the post-intervention assessment, and 20 completed the postpartum assessment. Frequencies and descriptive statistics were examined for all variables. To examine whether previously reported improvements in outcomes from baseline to post-intervention (anxiety, depression, worry, self-compassion, mindfulness) were maintained postpartum, a series of one-way repeated measures ANOVAs were used with three levels (baseline, post-intervention, postpartum). Post-hoc pairwise comparisons were used to examine significant overall changes over time.

To examine formal mindfulness practice, we assessed practice duration and practice frequency as continuous variables. Means and standard deviations were examined for number of weekly practices (frequency) and weekly practice time in minutes (duration) throughout the intervention phase of the study. Total practice time throughout the full intervention was calculated as the sum of weekly practice time. Home practice during postpartum was examined using frequencies and descriptive statistics.

Zero-order correlations were used to examine whether practice frequency or duration was correlated with outcomes (anxiety, depression, mindfulness, self-compassion, worry) at post-intervention and postpartum. To examine mindfulness practice and outcomes throughout the postpartum period, independent samples t tests were used to compare outcomes across individuals who were and were not still practicing meditation. To assess achieved power, we conducted post-hoc power analyses for the range of correlation coefficients observed in our results, based on a two-tailed significance test, alpha level of .05, and sample size of 23.

Results

Outcomes at Follow-Up

All outcomes were previously reported to significantly improve from baseline to post-intervention (Goodman et al. 2014a). All of these improvements were maintained or further improved into the postpartum period (Table 1). There was a

Table 1 Postpartum psychosocial outcomes

Outcome measure (clinical cut-off or normative mean)	Baseline[1] *M* (SD)	Post-intervention[2] *M* (SD)	Postpartum[3] *M* (SD)	*p* value[1–3]	*p* value [2–3]
Anxiety (≤ 10)	12.71 (8.74)	6.65 (5.28)	4.59 (4.43)	< .001	.15
Depression (≤ 13)	34.32 (14.68)	17.68 (16.33)	7.79 (5.87)	< .001	< .001
Worry (≤ 65)	51.86 (8.14)	43.00 (9.88)	41.79 (9.68)	< .001	.52
Mindfulness (*M* = 4.00)	3.38 (.65)	3.64 (.76)	3.60 (.69)	.02	.61
Self-compassion (*M* = 36.00)	31.55 (8.28)	39.20 (10.22)	38.00 (10.02)	.001	.36

Analyses were conducted among participants with complete data at each time-point: anxiety $n = 19$, depression $n = 19$, worry $n = 14$, mindfulness $n = 20$, self-compassion $n = 20$. Significant differences between baseline and post-intervention means were previously reported (Goodman et al. 2014a)

significant decrease over time in anxiety symptoms, $F(2,32) = 9.42$, $p < .001$, $\eta_p^2 = .37$, with a decrease from baseline to postpartum ($p < .001$) and no significant change from post-intervention to postpartum ($p = .15$). Worry scores significantly decreased over time, $F(2,26) = 12.12$, $p < .001$, $\eta_p^2 = .48$, with a significant decrease from baseline to postpartum ($p = .003$) and no significant change from post-intervention to postpartum ($p = .52$). There was a significant increase in mindfulness scores over time, $F(2,38) = 4.78$, $p = .02$, $\eta_p^2 = .20$, with a significant increase from baseline to postpartum ($p = .02$) and no change from post-intervention to postpartum ($p = .60$). Self-compassion scores showed a significant increase over time, $F(2,38) = 15.55$, $p < .001$, $\eta_p^2 = .45$, with a significant increase from baseline to postpartum ($p = .001$) and no change from post-intervention to postpartum ($p = .36$). For depression, $F(2,36) = 33.84$, $p < .001$, $\eta_p^2 = .65$, symptoms significantly decreased from baseline to postpartum ($p < .001$) and further decreased from post-intervention to postpartum ($p < .001$).

Formal Practice During the Intervention

Across the full intervention, participants completed an average of 103 total practices for an average total practice time of 1039.13 min (17.32 h; see Table 2). Weekly adherence for the sample was consistently above 50% (range = 54—80%).

Formal Practice at Post-Intervention and Postpartum

See Table 3 for home practice results at post-intervention and postpartum. At post-intervention, the majority of participants continued to practice meditation (91%) and yoga (65%). At postpartum, continued practice rates were lower though many continued to practice meditation (55%), and some continued to practice yoga (25%). The 3-min breathing space was the most commonly practiced exercise at post-intervention (76%) and postpartum (91%). At both time-points, approximately 50% of participants were practicing mindfulness less than three times per week; at post-intervention, the rest of the sample practiced more frequently than that, and at postpartum, the rest of the sample practiced less frequently.

Relationship Between Formal Practice and Outcomes

Post-hoc power analyses indicated a range of 5 to 33% power achieved. There were no significant associations between formal practice duration or frequency during the intervention phase of the study and any outcome at post-intervention or follow-up (Table 4). At postpartum, there were no significant differences in any outcome between those who were and were not still practicing meditation, though there was a trend for less worry among those who were still practicing ($M = 37.40$, SD = 10.24) compared to those who were not still practicing ($M = 47.50$, SD = 9.38; $p = .05$).

Discussion

The current study shows that among study participants, the mental and emotional health gains achieved after the initial 8-week CALM Pregnancy intervention continued from the end of the intervention in late pregnancy to 3 months postpartum. Scores on each measure at follow-up fell below the clinical cut-off and approached or exceeded normative means. Although these findings are preliminary and should be interpreted with caution given the lack of a control group, they complement the recent findings of Dimidjian et al. (2015, 2016) who found that MBCT delivered during pregnancy was associated with maintained improvements in depression symptoms and significantly lower rates of depression relapse through 6 months postpartum (Dimidjian et al. 2015, 2016). Given the tremendous stresses that can accompany the transition to parenthood and the mental health vulnerabilities this can create for new moms, it is important to identify interventions that can bridge the prenatal and postpartum periods by teaching pregnant women sustainable skills to manage stress and anxiety. These preliminary results provide further support that MBIs may be one way to improve psychiatric

Table 2 Descriptive statistics for formal practice throughout the intervention

Week (practice log response rate)	Recommendation	Practice frequency *M* (SD)	Practice duration *M* (SD)	Adherence (%)
Week 1 (100%)	Body scan, 6 days	4.17 (2.30)	125.00 (68.90)	69
Week 2 (96%)	Body scan, 6 days	3.48 (1.78)	104.35 (53.41)	58
Week 3 (96%)	Body scan, days 1, 3, 5 Mindful yoga, days 2, 4, 6	4.74 (1.54)	143.17 (46.31)	80
	3-MBS—regular	12.91 (6.72)	38.74 (20.16)	72
Week 4 (92%)	Sitting meditation, days 1, 3, 5 Mindful yoga, days 2, 4, 6	4.41 (1.68)	132.27 (50.42)	73
	3-MBS—regular	14.00 (6.23)	42.00 (18.68)	78
Week 5 (83%)	Sitting meditation daily	3.70 (2.56)	111.00 (76.70)	62
	3-MBS—regular	12.4 (8.49)	37.20 (25.46)	69
	3-MBS—responsive	5.75 (7.05)	17.25 (21.14)	–
Extra week 5 (87%)	Sitting meditation daily	2.54 (1.98)	76.15 (59.52)	42
	3-MBS—regular	9.85 (6.36)	29.54 (19.09)	55
	3-MBS—responsive	7.39 (8.26)	22.15 (24.79)	–
Week 6 (79%)	Daily practice of choice	3.79 (2.23)	113.68 (66.77)	54
	3-MBS—regular	12.11 (6.97)	36.32 (20.90)	67
	3-MBS—responsive	6.47 (7.93)	19.42 (23.80)	–
Week 7 (83%)	Daily practice of choice	4.20 (2.04)	126.00 (61.25)	60
	3-MBS—regular	10.05 (7.26)	30.15 (21.77)	
	3-MBS—responsive	4.28 (5.81)	12.83 (17.43)	–
Intervention total		103.00 (51.03)	1039.13 (447.18)	63

Time spent practicing is in minutes; all formal practices were 30 min long using a guided recording

3-MBS 3-min breathing space

Table 3 Formal practice patterns at post-intervention and postpartum

	Post-intervention *N* (%)	Postpartum *N* (%)
Still meditating	21 (91)	11 (55)
Amount of practice		
Less than once per week	–	5 (46)
Less than 3× per week	11 (52)	6 (54)
3×–6× per week	8 (38)	–
Daily	2 (10)	–
Type of practice		
3-min BS	16 (76)	10 (91)
Sitting meditation	5 (24)	3 (27)
Mindful breathing	2 (10)	–
Body scan	2 (10)	–
Still practicing yoga	15 (65)	5 (25)
Amount of practice		
Less than once week	3 (21)	1 (20)
Less than 3× per week	8 (57)	3 (60)
3×–6× per week	2 (14)	–
Daily	1 (7)	1 (20)

Post-intervention $n = 23$, postpartum $n = 20$. Practice types were not mutually exclusive and thus percentages sum to greater than 100%

functioning in pregnant women with benefits that can extend from pregnancy to post-delivery.

Rates of formal mindfulness practice were found to be relatively high in the current study, with at least 50% adherence to recommendations each week. Compared to other studies of pregnant women, participants in the current study seemed to practice as frequently but for longer durations. In previous

Table 4 Zero-order correlations between formal practice and outcomes

	Practice duration	Practice frequency
Post-intervention ($N = 23$)		
Anxiety	.11	− .04
Depression	.09	.04
Worry	.13	− .04
Mindfulness	.11	.09
Self-compassion	.14	.24
Postpartum ($N = 20$)		
Anxiety	− .12	− .25
Depression	.02	− .09
Worry	.00	− .14
Mindfulness	.09	.09
Self-compassion	.32	.30

studies, women often practiced 4 days per week for 5–10 min each time (Byrne et al. 2014; Guardino et al. 2014; Woolhouse et al. 2014), whereas participants practiced approximately 4 days per week for 30 min in the current study. It is also noteworthy that most participants continued to practice mindfulness post-intervention and into the postpartum period. Although home practice rates were generally lower postpartum as compared to immediately post-intervention, over half of women were still practicing at postpartum, most were practicing up to three times per week, and practice of the 3-min breathing space specifically was higher. Indeed, perhaps not surprisingly, the 3-min breathing space was the practice participants continued to use the most, supporting the idea that this particular practice is useful, accessible, and easily integrated into daily life (Segal et al. 2012). These results suggest the acceptability, perceived utility, and sustainability of formal mindfulness practices for pregnant women and new mothers.

In terms of associations between formal mindfulness practices and perinatal outcomes, contrary to prediction, formal mindfulness practice was not associated with any outcomes. Although these findings are non-significant, they are important given the limited and inconsistent literature on mindfulness practice and outcomes to date. In a review of 98 mindfulness intervention studies, only 24 studies assessed the relationship between home practice and outcomes, and only 13 found support for a positive relationship (Vettese et al. 2009). These inconsistencies make it difficult to offer evidence-based recommendations for clinical practice and raise questions regarding mindfulness training itself as a mechanism of action in MBIs, highlighting the need for continued research in this area. Understanding these associations in perinatal MBIs in particular is important for developing feasible and effective evidence-based recommendations that provide a sufficient amount of training without adding unnecessary burden to the existing demands of pregnancy.

One explanation for the lack of significant associations between formal practice and outcomes is that we were not powered to detect a significant relationship due to the small sample size and limited variability (overall high levels) in adherence. A post-hoc power analysis indicated very low power achieved, suggesting that the null findings may be due to inadequate power. Qualitative data from our previous study indeed suggest that the development of mindfulness skills was the most helpful aspect of the program, a theme expressed by 83% of the sample (Goodman et al. 2014a, b). It is worth noting, however, that the null findings are consistent with previous studies in larger samples that did not find associations between home practice and outcomes (Jain et al. 2007; Kabat-Zinn et al. 1987; Shapiro et al. 2003). It is possible that the current results reveal a true lack of a relationship for pregnant women, such that other life factors (e.g., the end of pregnancy) or aspects of MBCT are more important mechanisms of action for this group (e.g., peer support, psychoeducation, general engagement in self-care behavior). Mindfulness practice may lead individuals to experience new ways of thinking (e.g., reperceiving/cognitive decentering, self-efficacy, optimism), but these insights may also come as "aha moments" that are not entirely tied to amount of practice. It is also possible that we did not find a significant relationship because we did not assess informal practice.

Strengths, Limitations, and Research Directions

Strengths and limitations to the current study are worth noting. One strength is the follow-up assessment at 3 months postpartum. As compared to a standard follow-up over the natural course of time, this follow-up occurred after a major and likely very stressful life change. The fact that outcomes were maintained and many women still practiced meditation over this particular time period is noteworthy and may carry more weight than demonstrating improved outcomes over a typical 3-month period. A second strength is the inclusion of a sample with clinically elevated anxiety symptoms, as most previous studies of perinatal MBI's did not enroll women with elevated baseline symptoms (Taylor et al. 2016). Third, response rates for turning in the weekly practice logs were relatively high with the lowest rate at 79%.

This study also reports session-by-session adherence rates and offers new insight regarding the role of home practice in perinatal MBI's. Although mindfulness practitioners, teachers, and researchers often assume there is an association between amount of practice and outcomes, there is currently no conclusive evidence to support this idea, either in the perinatal mindfulness literature or mindfulness literature more broadly. As mentioned above, it is possible that other factors are more important than amount of formal practice. Until there is clear evidence that amount of practice correlates with outcomes, it is important for mindfulness teachers and researchers to be open-minded and consider all options when making practice recommendations. The current study underscores the important need for further research in this area, and the need for openness and flexibility among perinatal MBI researchers and clinicians in particular.

In terms of limitations, this was an uncontrolled, non-randomized pilot study with a small sample size. The small sample size might have limited the ability to detect a relationship between formal practice and outcomes, and self-selection bias limits the generalizability of the results. For example, the limited variability due to relatively high adherence rates is a statistical limitation and could be related to the fact that participants who enrolled were particularly motivated and interested in learning mindfulness skills. The lack of a control group prevents causal inferences regarding the effects of the intervention specifically. This is problematic in the context of perinatal interventions given that levels of anxiety tend to attenuate over the course of pregnancy without intervention

(Heron et al. 2004). Randomized controlled trials in larger samples are needed to better understand the relationship between home practice and outcomes in perinatal MBIs. These interventions should use active control groups, such as comparing mindfulness interventions to typical childbirth classes and other usual care interventions to establish whether mindfulness training has any incremental effect on outcomes. Another limitation is that we did not collect data on informal practice, which is part of recommended practice in MBCT and is important to examine alongside formal practice, as participants may practice one more than the other (Dimidjian et al. 2016) and the two can show different associations with outcomes (Crane et al. 2014). Lastly, formal practice was measured by weekly self-report logs during the intervention phase, and retrospective self-report at 1 week post-intervention and postpartum, which are subject to potential self-report and recall bias. We also did not collect detailed data on formal practice after completion of the intervention.

Perhaps most importantly, we were unable to use a validated measure of formal practice because no standardized measure or measurement currently exists (Vettese et al. 2009; Wahbeh et al. 2011). Researchers have quantified formal practice in several different ways (e.g., frequency or duration of formal or informal practice, adherence based on various cutoff points; Carmody and Baer 2008; Crane et al. 2014; Elwafi et al. 2013; Fjorback et al. 2011; Perich et al. 2013; Rosenzweig et al. 2010; Sephton et al. 2007; Tamagawa et al. 2015). The lack of standardized measures may be related to the inconsistent literature regarding mindfulness practice and outcomes (Vettese et al. 2009). We attempted to control for this by using multiple measurements and found similar results across each one. Nonetheless, developing validated mindfulness practice measures is an important area for future research. Incorporating mobile technologies (e.g., smartphone applications) that record the number and duration of each practice session may be one way to feasibly and objectively measure mindfulness practice (Wahbeh et al. 2011). Informal practice presents even greater challenges in terms of reporting and measurement, but might also be captured using real-time assessments via mobile technologies (Killingsworth and Gilbert 2010). Ecological momentary assessment techniques would allow participants to report on formal practice patterns more regularly throughout the course of the intervention and provide more precise, real-time estimates of practice.

Overall, results from this single-arm study suggest that MBCT may be associated with improved mental health outcomes for women during pregnancy and postpartum, and women are able to practice formal mindfulness exercises regularly both during and after the intervention. The role of formal mindfulness practice for outcomes, however, remains unclear. Ultimately, large RCTs will be required to rigorously test the sustained effects of perinatal MBIs and role of mindfulness practice, and the current results support these next steps for future research. Given that no research has previously explored the role of formal practice in perinatal MBI outcomes, the current analyses may be a useful first step, which we hope will motivate further research in this area. Future research should also focus on developing validated measures of mindfulness practice, particularly using ecological momentary assessment approaches to measure mindfulness practice regularly in real-time.

Author Contribution CML completed the data analyses and wrote the paper; ERP assisted with the data analyses and edited the paper; JHG designed and executed the study, contributed to writing and editing the paper.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval 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. The Partners IRB at Massachusetts General Hospital provided IRB approval for this study.

Informed Consent All participants completed IRB-approved informed consent procedures before participating in the study.

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