RESEARCH





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Abstract

Background Although secular mindfulness interventions draw from contemplative traditions emphasizing relationality, evidence for impacts of such interventions on relational outcomes remains inconsistent. This study was designed to clarify conditions under which mindfulness training can improve relational functioning in a perinatal context where quality of relationship-building carries particularly important consequences for intergenerational health.

Methods We used a randomized controlled trial to test effects of prenatal participation in Mindfulness-Based Childbirth and Parenting (MBCP) vs. community birthing classes on trajectories of anxious birthing-people's individual (dispositional mindfulness, mental health, parenting stress) and relational (mindfulness in parenting, compassion, bonding with the fetus/infant) functioning across pre-intervention, post-intervention, and 3-month postnatal follow-up assessments. Multilevel growth curve models examined both main effects of intervention and moderation by participants' baseline risk and mindfulness dosage.

Results We found a main effect favoring MBCP on parenting stress only. Moderation models revealed significant effects of MBCP in predicted directions on both individual and relational outcomes for birthing-people with lower sociodemographic risk but elevated anxiety at baseline, as well as for those who engaged more with mindfulness practice both during and following the class.

Conclusions This study shows relational benefits of prenatal mindfulness training depend on birthing-people's baseline risk characteristics and practice dosage. Insight into sources of differential impact can guide further targeting and adapting mindfulness interventions to better support well-being in diverse families.

Trial registration This study was registered prospectively at ClinicalTrials.gov ID NCT05241600 (protocol identifier 19,461 starting 12/1/2018 at IL site and identifier 19,138 starting 1/26/2022 at PA site).

Keywords Mindfulness, Randomized Controlled Trial, Perinatal, Relational, Longitudinal

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Background

Although the roots of mindfulness emphasize benefits extending beyond the individual toward collective flourishing [1], important questions about the conditions under which secular mindfulness training brings about such relational benefits remain unanswered. The perinatal period from pregnancy through early postnatal development is a time when interdependence and relationality become particularly salient, and when effects on the individual child-bearer can plausibly exert cascading effects through parent-infant processes [2]; however, evidence for whether this occurs and what is necessary to enable such a cascade remains sparse. In this study, we aim to solidify knowledge about the reach of mindfulness training impacts by testing main effects and moderators of a prenatal mindfulness program on trajectories of birthing-people's mindfulness, compassion, and bonding with their baby across pregnancy and the first several months postpartum. Importantly, we combine the rigor of a randomized controlled trial with an ecologically valid comparison of child-bearers assigned to either a publicly available Mindfulness-Based Childbirth and Parenting program or a (non-mindfulness-based) community birthing class of their choice. By selecting child-bearers with higher levels of anxiety from a community setting, we further hope to clarify the boundary conditions for benefits in a higher-risk group.

Over the past several decades, interventions designed to train mindfulness-operationalized as "awareness that arises through paying attention in a particular way: on purpose, in the present moment, and non-judgmentally" [3]—have proliferated, and these mindfulness-based interventions have been shown to improve a variety of mental and physical health outcomes [4]. Meta-analyses have typically demonstrated more reliable effects of mindfulness training on individual well-being, with moderate-sized effects on psychological distress in adult community samples [5]. These effects, in turn, appear to be partially mediated through increases in self-reported mindfulness following mindfulness intervention or another active treatment condition [6]. Attempts to capture the impact of mindfulness on relational well-being have yielded mixed evidence; one meta-analysis that included a range of mindfulness intervention operationalizations (including one-time treatments and matched groups of meditators vs. non-meditators) showed an effect of mindfulness on prosocial behavior more broadly [7], whereas others demonstrated effects only under certain conditions [8, 9]. In particular, these latter studies suggest mindfulness intervention effects on prosociality may only hold in comparison to inactive control conditions, for certain prosocial outcomes, and over shorter assessment time periods. It thus remains uncertain whether mindfulness training, compared to other active training conditions, can bring about benefits for interpersonal connectedness over the longer term. Recent syntheses of the literature have called for further controlled studies that can demonstrate effects on a range of relevant prosocial outcomes over time [10].

Given the interconnectivity of parent and fetus/infant during the perinatal period and the consequential nature of that relationship for further development, the benefits of perinatal mindfulness training may be of particular interest. Although a newer area of research compared to mindfulness interventions in the general population discussed above, there is accumulating evidence that prenatal mindfulness training can support birthing-person and/or infant well-being across perinatal development and beyond [11–13]. A review surveying a mix of experimentally controlled and guasi-experimental parent mindfulness studies confirmed effects of mindfulness training on the child-bearer's own mental health and parenting stress, as well as their dispositional mindfulness and mindfulness in parenting-a related but distinct construct that encompasses dimensions of mindfulness and compassion in relation to the self, the child, and the parent-child relationship [14]. The concept of mindfulness in parenting itself implies relationality, though the research explicitly examining relational outcomes of perinatal mindfulness intervention remains limited. Several studies have investigated effects on mother-infant bonding; these have generally been conducted in small, lowrisk samples and/or have failed to demonstrate effects specific to mindfulness intervention [15-18]. To better understand whether prenatal mindfulness training can impact a range of relational outcomes, larger samples that allow tests of moderating factors may be instructive.

Indeed, the broader mindfulness research base highlights variability in intervention effects attributable to characteristics of both the participants themselves and their engagement with the training. For example, greater mindfulness practice dosage both during and following the intervention may boost impacts on individual mindfulness and/or well-being outcomes [19-21]. Baseline features of participants including sociodemographic risk, mindfulness, and mental health may also play a role in the effectiveness of mindfulness training [22-25]. In reference to perinatal mindfulness more specifically, there is evidence for dosage effects such that child-bearers who continued practicing following prenatal intervention showed more sustained effects on mood and mindfulness over a 12-month period [26]. There is also evidence for moderating effects of baseline symptom severity and/ or socioeconomic context on child-bearers'internalizing distress and mindfulness measured immediately postintervention [27], as well as trajectories of distress up

to one year postpartum [28]. While these studies suggest prenatal mindfulness training may exert durable effects for certain birthing-people, there remains a lack of research demonstrating longer-term effects on relational outcomes, and a need for research in more diverse samples that can explore moderating factors in this population has been identified [29].

The above research points to both the potential promise of mindfulness intervention during the perinatal period for benefits extending beyond the individual, and a lingering evidence gap. There are converging calls to demonstrate longer-term mindfulness training effects in community samples with active controls, to attend more closely to dosage effects, and to examine trajectories over time. In the mindful parenting area specifically, there is a need for further experimental investigation of relational outcomes and potential moderators of effects in diverse samples that extend beyond the married, upper-SES participants typically included in this research [30, 31].

The current study

In an effort to answer the above calls and ground claims about possible relational impacts of perinatal mindfulness training, we conducted a randomized controlled trial (RCT) study of the Mindfulness-Based Childbirth and Parenting (MBCP) program in a community sample. As described further below, MBCP applies the principles and practices of mindfulness to preparing for childbirth and parenting an infant [32]. Certain distinguishing features of MBCP—i.e., delivery in a group format with child-bearers and their partners, inclusion of exercises involving dyadic communication and awareness of connection with the fetus—make it inherently more relational than many other mindfulness-based interventions, and as such an ideal testing ground for examining such effects.

Research on MBCP across varying cultural contexts has demonstrated improvements in child-bearers' fear of childbirth and birth outcomes, mental health (depression, anxiety), and mindfulness [33-36]. This work has typically examined MBCP effects under controlled conditions—i.e., with one or more facilitators affiliated with the research group, and with a consistent comparison condition such as Lamaze or Enhanced Care as Usualand has not included quantitative measures of relational outcomes over time. Here, we aimed to test MBCP effectiveness for both individual (dispositional mindfulness, mental health, parenting stress) and relational (mindfulness in parenting, compassion, bonding with the fetus/ infant) outcomes under more naturalistic conditions; this meant comparing participants taking MBCP from various instructors not connected to the project against those given a choice of (non-mindfulness-based) community childbirth preparation classes in the active control condition. We further sought to recruit a sample of birthingpeople not limited to those with a married partner to distinguish how much the intervention's effects rely on this form of support. We selected participants from a non-clinical setting who nevertheless reported elevated anxiety to speak to MBCP's value as a universal prevention strategy in a higher-risk community group. Finally, we examined both main effects of treatment condition and effects moderated by mindfulness dosage (hours during the program itself and post-program practice), sociodemographic risk (age, cohabiting partner), and baseline well-being (mental health symptoms) on trajectories of the above outcomes across pre-intervention, post-intervention, and a 3-month postnatal follow-up.

Guided by the research reviewed above, we predicted that child-bearers participating in MBCP would show improved individual and relational outcome trajectories compared to those in community birthing classes, but that benefits would depend on moderating factors. Specifically, we expected better outcomes—higher postintervention intercepts and/or more positive slopes—for MBCP participants with greater baseline risk (more mental health symptoms, younger, no cohabiting partner), and for those who received a greater mindfulness training dosage during and/or after the program. These aims and hypotheses are part of a preregistered report on clinicaltrials.gov (NCT05241600).

Methods

Participants and procedure

Pregnant people were recruited through social media and community events in central Illinois (June 2019-December 2021) and central Pennsylvania (January 2022-August 2023) to participate in an RCT of MBCP classes compared to community birthing classes. Due to the COVID-19 lockdown that began in March 2020 in the United States, we adapted the study design from fully in-person (June 2019-March 2020), to fully online (March-August 2020), to a hybrid design (August 2020-August 2024). These changes involved moving early in-person sessions online, offering a mix of in-person and online birthing classes, and extending the time period in which we planned to conduct in-person home visits and MRIs from the third month postpartum to 3-6 months postpartum. Throughout the changes necessitated by the global pandemic, we endeavored to maintain fidelity to the study design. The study adheres to CONSORT guidelines as reported further below.

Eligibility criteria included being less than 28 weeks' gestation, expecting a singleton birth, being between the ages of 18 and 40, speaking fluent English, being willing to be randomized to a birthing class, and a Penn State

Worry Questionnaire score greater than 50, indicating moderate to high worry. Exclusion criteria included formal training in meditation or a long-term yoga practice, pregnancy complications that prohibited the participant from engaging in a birthing class, and MRI contraindications (e.g., claustrophobia, braces, etc.). An initial criterion of primiparity was dropped in August 2020 due to low recruitment rate of eligible participants. Participant enrollment continued until reaching the target *n* of 30 in each arm completing T1-3 assessments as laid out in the original grant aims. Figure 1 depicts the flow of potential participants screened, enrolled, and participating in different parts of the study procedures, as well as reasons for exclusion at each phase.

The trial design was a parallel randomized controlled trial with 1:1 allocation to MBCP or community class arms. Eligible participants were invited to participate in a consent session, where they were informed about the



Fig. 1 CALM consort diagram. *Reasons for ineligibility included PSWQ score < 50 (n = 165), multiparity (discontinued criterion; n = 86 before change in protocol), distance from neuroimaging center > 50 miles (n = 42), gestational age > 28 weeks (n = 39), previous mindfulness experience (n = 25), MRI contraindications (n = 15), multiple pregnancy (n = 7), pregnancy complications preventing participation in birthing class (n = 5), non-English speaking (n = 3), maternal age > 40 (n = 2)

study and provided their and their partner's availability. Following consent, the principal investigator assigned participants to either the MBCP or community condition using variable block randomization, with blocks determined by incoming participants' potential availability for an upcoming MBCP class based on their gestational age window (see similar considerations in previous prenatal clinical trials [36, 37]). Within blocks, a coin toss was initially used to determine assignment to condition and participants were allocated sequentially until evenly distributed across study arms (e.g., if both of the first 2 coin tosses for a block of 4 resulted in MBCP allocation, the remaining 2 were allocated to community class; if one or more of these participants was unavailable for the MBCP class/es offered, they were allocated to community class and the next participant/s allocated to MBCP as needed to balance conditions). Given that many participants enrolled over the course of the study proved unavailable to attend the MBCP class/es offered during their window of eligibility, this meant that the majority of participants who could attend an MBCP class offering were allocated to this condition to balance those who could only take part in the community class condition, consistent with recommendations to take such logistical concerns into account to increase external validity of clinical trials [38]. The principal investigator was blind to all other participant details, as were research staff involved in ongoing follow-up and data collection. Due to the nature of the interventions, neither participants nor intervention leaders could be blinded to study condition.

The demographic composition of the enrolled sample reflects the communities in which recruitment occurred, which meant participating mothers identified themselves primarily as White (76.5%) and non-Hispanic (90.1%), and either Christian (53.1%) or spiritual but not religious (24.7%). Although the majority had a college degree or higher, a substantial proportion (21%) did not, and the median reported household income in the \$80,000-\$90,000 range was below the state median for a family of 3 in both IL and PA. Similarly, although a majority were married to their child's biological parent with a median relationship length of 5–6 years, a substantial minority (20.3%) were not married. See Table 1 for a breakdown of sample characteristics by condition assignment and overall.

Between 20- and 28-weeks gestation, the research coordinator contacted participants by phone to share their birthing class assignment and the baseline questionnaire (timepoint 1 [T1]). Participants completed their assigned birthing class between 20- and 37-weeks gestation. Participants with a partner were encouraged to include their partner in the birthing class. At 37-weeks gestation, participants were asked to complete the post-class questionnaire (timepoint 2 [T2]). Following birth—between 3- and 6-months postpartum—participants were invited to complete the post-birth follow-up questionnaire, as well as to participate in a home visit and MRI session (timepoint 3 [T3]). The home visit and MRI assessments were conducted to address a separate study aim not reported in the current paper, but which is described in the preregistered protocol.

All women gave informed consent prior to participation and all study procedures were in accordance with the Declaration of Helsinki, approved by the University of Illinois and/or the Pennsylvania State University's institutional review boards. Participants were provided free birthing classes (up to a value of \$350) and compensated for each study session, for a total of \$120 if they completed the entire study. Participants assigned to birthing classes with more than six classes were given additional compensation (\$20) if they attended all classes.

Intervention

Mindfulness-based childbirth and parenting classes

MBCP is a wellness promotion program designed to support the physical and psychological well-being of childbearers, their children, and the family unit [39]. Adapted by Nancy Bardacke, CNM, from Kabat-Zinn's Mindfulness-Based Stress Reduction (MBSR), MBCP includes the core elements and structure of MBSR modified for the perinatal context, in addition to psychoeducation components to prepare parents for the demands of childbirth and parenting a newborn.

Over the course of 9 weeks, groups of child-bearers and their partners meet with a birthing and mindfulness teacher for weekly three-hour classes and to engage in a full-day retreat, for a total of 33 h of instruction. In addition, participants are invited to engage in about an hour of daily home practice. Course content includes perinatal psychoeducation, childbirth and parenting skills development, group discussion, informal "mindfulness in everyday life" practices; and four types of formal meditations—focused attention, open monitoring, movement, and loving-kindness.

Participants in the MBCP condition were assigned to one of four in-person and/or online Zoom MBCP classes that were open to the public: Mindful Birthing CU (n= 25), the Mindful Birthing and Parenting Foundation (n= 13); Oracle Maternity and Baby (n= 2); and Mindful Birthing and Parenting Philadelphia (n= 2). Five participants assigned to MBCP withdrew from the study before attending their first class. All teachers had completed the Mindful Birthing and Parenting Foundation's Teacher Training certification. Mindful Birthing CU implemented an eight-week form of MBCP that has been used in previous RCTs [34–36].

Table 1 Sample descriptives

Variable n (%) for categorical or M (5D) for continuous	MBCP Class $(n - 42)$	Community Class (n = 39)	Total (<i>n</i> = 81)	
	(11 - 42)	(11 – 57)		
Site				
IL	21 (50.0%)	19 (48.7%)	40 (49.4%)	
PA	21 (50.0%)	20 (51.3%)	41 (50.6%)	
Age	31.12 (3.31)	29.45 (4.28)	30.33 (3.87)	
Race				
White	34 (81.0%)	28 (71.8%)	62 (76.5%)	
Black	4 (9.5%)	4 (10.3%)	8 (9.9%)	
Asian	1 (2.4%)	1 (2.6%)	2 (2.5%)	
Other	0 (0%)	4 (10.3%)	4 (4.9%)	
No answer	3 (7.1%)	2 (5.1%)	5 (6.2%)	
Ethnicity				
Non-Hispanic	39 (92.9%)	34 (87.2%)	73 (90.1%)	
Hispanic/Latinx	3 (7.1%)	5 (12.8%)	8 (9.9%)	
Religion				
Christian	21 (50.0%)	22 (56.4%)	43 (53.1%)	
Hindu	0 (0%)	1 (2.6%)	1 (1.2%)	
Buddhist	0 (0%)	1 (2.6%)	1 (1.2%)	
Spiritual, no religion	13 (31.0%)	7 (17.9%)	20 (24.7%)	
Other	8 (19.0%)	8 (20.5%)	16 (19.8%)	
Education				
High school graduate or less	4 (9.5%)	2 (5.2%)	6 (7.4%)	
Trade/technical school or some college	3 (7.1%)	8 (20.5%)	11 (13.6%)	
College graduate	11 (26.2%)	16 (41.0%)	27 (33.3%)	
Graduate training	7 (16.7%)	2 (5.1%)	9 (11.1%)	
Graduate degree	17 (40.5%)	11 (28.2%)	28 (34.6%)	
Income				
<\$25.000	5 (11.9%)	5 (12.8%)	10 (12.3%)	
\$25.000-\$50.000	2 (4.8%)	7 (18.0%)	9 (11.1%)	
\$50.000-\$80.000	9 (21.4%)	5 (12.8%)	14 (17.3%)	
\$80.000-\$100.000	8 (19.0%)	4 (10,3%)	12 (14.8%)	
\$100.000-\$150.000	10 (23.8%)	10 (25.6%)	20 (24.7%)	
>\$150.000	8 (19.1%)	6 (15.4%)	14 (17.3%)	
No answer	0 (0%)	2 (5.1%)	2 (2.5%)	
Relationship Status				
Dating child's parent	5 (11.9%)	8 (20.5%)	13 (16.0%)	
Engaged to child's parent	1 (2 4%)	2 (5 1%)	3 (3 7%)	
Married to child's parent	.35 (83.3%)	28 (71.8%)	63 (77 8%)	
No answer	1 (2 4%)	1 (2 6%)	2 (2 5%)	
Cohabiting with Partner	39 (92 9%)	35 (89 7%)	74 (91 4%)	
Number of People in Home	2 51 (95)	2 76 (1 02)	2 63 (99)	

Numbers reflect participants allocated to a condition who completed T1 baseline assessment

Participants allocated to MBCP reported a range of hours engaging with their classes during the intervention period as a whole (0–33 h in class, M= 18.97, SD= 10.26; 0–50 h outside of class, M= 15.35, SD= 14.82), as well as time spent in regular ongoing practice after the class had ended (0–7 h per week, M= 1.29, SD= 1.82 at T3 assessment).

Community birthing classes

Participants assigned to the community class condition were provided a list of online and in-person birthing classes available locally and nationally to choose from. Participants chose to enroll in hospital-based birthing classes (n = 16), an online class for couples (n = 9), Bradley Method classes (n = 4), natural birthing classes (n = 4), Doula-led personalized birthing classes (n = 1), and Lamaze classes (n = 1). Five participants withdrew before attending a class.

All community classes included psychoeducation content on prenatal health, childbirth, pain management during labor, and postpartum and newborn care. Most classes also included brief psychoeducation on perinatal mental health. While most community classes included instruction on relaxation-based pain management techniques and some included visualizations and/or meditations, classes were screened by a research coordinator to ensure that they did not explicitly incorporate mindfulness into their curriculum.

Methods of delivery ranged from one-on-one in-person or Zoom classes, group in-person or Zoom classes, and online platforms that provided participants access to videos and other educational materials that participants could consume at home at their own pace. Total instruction time ranged from 2–20 h.

Participants allocated to community classes reported a range of hours actually spent engaging with their classes during the intervention period (0–20 h in class, M= 6.01, SD= 3.96; 0–15 h outside of class, M= 2.68, SD= 3.76), as well as time spent continuing to practice skills learned after the class had ended (0–7.5 h per week, M= 0.68, SD= 1.76 at T3).

Measures

Primary

Mindfulness was assessed with the Five Facet Mindfulness Questionnaire (FFMQ [40]) at each of the 3 timepoints. Participants rated each of the 39 items from 1 (never or very rarely true) to 5 (very often or always true) to derive scores for each of the five facets as well as a total score. Example items include "I find it difficult to stay focused on what's happening in the present" (Acting with Awareness—reversed) and "When I have distressing thoughts or images, I just notice them and let them go" (Nonreactivity). The internal consistency was good across timepoints for each of the subscales (alpha = 0.73-0.83 for Observing, 0.88-0.94 for Describing, 0.87-0.92 for Acting with Awareness, 0.91-0.92 for Nonjudging, 0.84-0.86 for Nonreactivity), as well as for the total (alpha = 0.91-0.94).

Mindfulness in parenting was measured at the third timepoint only with the Interpersonal Mindfulness in Parenting-Infant Version (IMP-I [41, 42]). Twenty-seven items were rated from 1 (never true) to 5 (always true) to calculate five subscale scores and a total score. Example items include "I find myself distracted when I am with my baby because I am busy doing or thinking about something else at the same time" (Listening with Full

Attention—reversed) and "I try to be understanding and patient with my baby when they are having a hard time" (Compassion for Self and Child). The internal consistency varied across subscales (alpha = 0.84 for Listening with Full Attention, 0.47 for Emotional Awareness of Self and Child, 0.70 for Self-Regulation in the Parenting Relationship, 0.39 for Nonjudgmental Acceptance of Self and Child, 0.73 for Compassion for Self and Child) but high for the total score (alpha = 0.88).

Compassion was indexed through the Compassion Scale (CS [43]), administered at each timepoint. Participants rated 24 items from 1 (almost never) to 5 (almost always) to derive six subscale scores and a total score. Example items include "I don't feel emotionally connected to people in pain" (Separation – reversed) and "My heart goes out to people who are unhappy" (Kindness). Here, too, the internal consistency for subscales was variable (alpha = 0.61-0.75 for Kindness, 0.64-0.73 for Indifference, 0.50-0.65 for Common Humanity, 0.70-0.74 for Separation, 0.42-0.72 for Mindfulness, 0.54-0.65 for Disengagement) but good for the total score (alpha = 0.77-0.83).

Maternal Attachment (MA) was measured using two versions of a similar scale adapted for pregnancy vs. postpartum: the Maternal Antenatal Attachment Scale [44] at the first two timepoints and the Maternal Postnatal Attachment Scale [45] at the final timepoint. Each measure comprises 19 items scored from 1 to 5 (variable anchor descriptions), with higher scores indicating stronger attachment to the fetus or infant. Whereas the former scale contains two subscales (Quality of Attachment and Intensity of Preoccupation), the latter contains three (Quality of Attachment, Absence of Hostility, and Pleasure in Interaction). Example items include "Over the past two weeks I have felt: Very emotionally distant to Very emotionally close to my baby" (Antenatal Attachment - Quality) and "Over the last two weeks I would describe my feelings for the baby as: Dislike to Intense Affection" (Postnatal Attachment – Quality). The internal consistency varied across subscales (alpha = 0.66-0.77 for Quality of Attachment, 0.61-0.67 for Intensity of Preoccupation, 0.67 for Absence of Hostility, 0.41 for Pleasure in Interaction) and was higher for total scores (alpha = 0.78-0.82).

Secondary

Measures of child-bearer mental health were also administered at all timepoints to address hypothesized moderators and secondary outcomes. These included the Center for Epidemiological Studies Depression Scale (CESD [46]), the Edinburgh Postnatal Depression Scale (EPDS [47]), the Penn State Worry Questionnaire (PSWQ [48]), the Perceived Stress Scale (PSS [49]), and the Ruminative Response Scale (RRS [50]). Internal consistencies for all of these were good (alpha = 0.90-0.93 for CESD, 0.87-0.93 for EPDS, 0.90-0.92 for PSS, 0.92-94 for PSWQ, 0.94-0.96 for RRS).

For use in analysis, all of the above (sub)scale scores were calculated as item means and standardized; this means that all model effects are reported for Z-scores. Class condition was dummy-coded such that 0 represented community class and 1 represented MBCP.

Data analysis plan

All analyses were conducted using intent-to-treat principles to provide a rigorous test of hypothesized effects. Multilevel growth curve modeling in HLM was used to examine MBCP-related differences in outcome trajectories across the study period from pregnancy through postpartum. This approach is advantageous for examining longitudinal effects in the presence of missing data, in that it uses full information maximum likelihood estimation to provide parameter estimates based on available data. Level 1 modeled each participant's repeated measurements of a given outcome with an intercept and linear slope; linear terms were centered so that intercepts reflected outcome levels at T2 (post-class) or T3 (follow-up, for models involving postclass practice dosage). At Level 2, individual differences in these trajectories were explained by (1) class condition (MBCP vs. community class) for main effects models, and (2) the interaction of class condition with hypothesized moderators for moderated effects models. Linear regression was used to test effects for the mindfulness in parenting outcome measure administered at T3 only.

To test the hypothesized effects presented above and in our clinical preregistration, we first examined main effects of MBCP on primary outcome measures, followed by secondary outcome measures. We then examined effects moderated by baseline risk characteristics and mindfulness dosage on each of these outcomes. Questionnaire total scores served as the main outcomes, though subscale scores (as applicable) were also examined. Significant interaction effects on primary outcomes were decomposed through region of significance testing using an online calculator [51] for further interpretation.

Results

Table 2 shows descriptive information for all raw (nonstandardized) scale scores across timepoints, and Table 3 shows correlations among scores (averaged across timepoints) for reference.

Randomization check

Participants' baseline characteristics were compared across class allocation conditions (independent samples

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Table 2 Scale descriptives across timepoints

Variable	T1 <i>M, SD</i>	T2 <i>M, SD</i> Change from T1	T3 <i>M, SD</i> Change from T1
Primary			
FFM Mindfulness	3.32,.45	3.40,.50 24	3.38,.55 12
IMP Mindfulness in Parenting			3.93,.42
CS Compassion	4.22,.34	4.22,.32 .061	4.19,.37 .067
MA Attachment	4.07,.36	4.25,.37 60	4.29,.46 54
Secondary			
CESD Depression	.80,.56	.65,.46 .29	.54,.48 .50
EPDS Perinatal Depression	.79,.50	.67,.47 .24	.59,.48 .34
PSWQ Anxiety-Worry	3.60,.75	3.51,.68 .28	3.46,.84 .19
PSS Perceived Stress	1.76,.72	1.69,.73 .12	1.60,.75 .17
RRS Rumination	2.00,.60	1.86,.57 .21	1.81,.63 .30

Change effects represent Cohen's D for paired samples t-tests

t-tests for continuous variables, Wald tests of proportions for categorical variables) to check whether the randomization procedure had succeeded in creating comparable groups. No significant differences in sociodemographic characteristics, primary or secondary outcome measures were found at T1, t(78) = 0.25-1.96 and Z = 0.58-1.29, all p's >0.05, lending support for group equivalency prior to treatment.

Hypothesis testing – main effects of MBCP

First, baseline models were fit to establish whether there was reliable between-participant variability in outcome trajectories. Overall, there was no evidence of sample-wide change in most outcome measures; the exceptions were bonding (increasing MA slope; $\gamma = 0.101$, SE = 0.036), and depression (decreasing CESD and EPDS slopes; $\gamma = -0.083$, SE = 0.035 and $\gamma = -0.104$, SE = 0.047, respectively). Importantly, we confirmed significant variability across participants in intercepts, $\chi^2(65) = 313.24-999.24$, and slopes, $\chi^2(65) = 88.95-159.19$, all p < 0.05, supporting the addition of explanatory predictors at Level 2.

To test the main effects of MBCP, class condition—a dummy-coded variable indicating MBCP allocation— was added as a Level 2 predictor of outcome intercepts and slopes. The only significant main effect detected involved a secondary outcome; MBCP predicted a lower perceived stress intercept ($\gamma = -0.19$, *SE* = 0.083). This

Variable	1	2	3	4	5	6	7	8	9
1. FFM	_								
2. IMP	.59	_							
3. CS	.35	.26	-						
4. MA	.41	.71	.27	_					
5. CESD	62	46	029	32	-				
6. EPDS	68	44	094	31	.89	-			
7. PSWQ	64	47	029	34	.70	.73	-		
8. PSS	74	48	19	32	.82	.85	.69	_	
9. RRS	63	50	072	40	.82	.74	.69	.76	-

Table 3 Correlations among study measures

All variables except IMP (administered at T3 only) represent means across timepoints. Significant correlations (p <.05) indicated in bold

means that participants in the MBCP condition reported lower levels of perceived stress following the class compared to those in the community class condition.

Hypothesis testing - moderated effects of MBCP

Adding interaction terms revealed a number of significant moderated effects of MBCP, described below by outcome domain.

For the dispositional mindfulness outcome, baseline sociodemographic and mental health risks emerged as significant moderators of MBCP effects, as did postclass mindfulness dosage. MBCP x Cohabiting Partner predicted higher Nonreactivity and Acting with Awareness subscale slopes, and MBCP x Age predicted a higher Observing subscale intercept. MBCP x T1 PSWQ depression predicted a higher total FFMQ intercept. Finally, MBCP x Post-Class Practice Hours predicted higher total FFMQ intercepts and slopes (see Table 4). Together, these effects pointed to better outcomes for MBCP participants who began the study with lower sociodemographic risk characteristics but greater worry, as well as for those who continued to engage in mindfulness after the class was over.

Region of significance analysis revealed that for participants with higher baseline worry (69 th %ile and above), MBCP predicted a more positive mindfulness slope compared to the community class condition (lower bound out of range of observed values; see Fig. 2). For the dosage effect, the region of significance showed that for those who engaged in continuing practice (83rd %ile and above), MBCP predicted higher mindfulness levels at follow-up and a more positive overall slope compared to the community class condition (lower bound out of range; see Fig. 3).

For the compassion outcome, similarly, we found MBCP effects moderated by baseline sociodemographic

Predictor	FFMQ Total		FFMQ Act w	FFMQ Act with Awareness		FFMQ Nonreactivity		FFMQ Observing	
	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	
1. MBCP			45,.54	49,.12	55,.58	21,.12			
Partner			-0.31,.35	28,.061	39,.57	21,.079			
MBCP x Partner			.31,.56	.54,.14	.50,.59	.31,.14			
2. MBCP							.077,.12	.12,.072	
Age							-13,.078	.062,.055	
MBCP x Age							.27,.11	034,.086	
3. MBCP	027,.085	.057,.047							
T1PSWQ	33,.065	072,.027							
MBCP x T1PSWQ	.14,.086	.10,.040							
4. MBCP	.22,.14	.094,.045							
Post-Class Hrs	-1.0,.46	085,.11							
MBCP x Post-Class Hrs	1.51,.64	.53,.22							

Table 4 Predictive model results - moderated effects of MBCP on mindfulness trajectories

FFMQ Five Facet Mindfulness Questionnaire. Dichotomous predictors (MBCP, Partner) represent 0/1 dummy-codes; continuous predictors represent Z-scores. Significant moderated effects (*p* <.05) highlighted in bold



Fig. 2 Baseline worry moderates the effect of MBCP on mindfulness—predicted FFMQ trajectories across timepoints by class condition at the boundary of the region of significance



Fig. 3 Post-class mindfulness practice moderates the effect of MBCP on mindfulness—predicted FFMQ trajectories across timepoints by class condition at the boundary of the region of significance

	CS Total		CS Kindness		CS Mindfulness		
Predictor	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	
1. MBCP	28,.30	37,.16					
Partner	18,.20	24,.11					
MBCP x Partner	.28,.31	.41,.16					
2. MBCP			006,.10	021,.056	064,.092	.095,.059	
Age			11,.069	008,.035	17,.054	066,.036	
MBCP x Age			.25,.098	.044,.058	.30,.091	.017,.070	
3. MBCP					097,.0F92	.071,.057	
T1 CESD					.11,.053	.025,.024	
MBCP x T1 CESD					22,.088	064,.066	
4. MBCP	.31,.099	.067,.070					
Class Hrs	54,.12	039,.11					
MBCP x Class Hrs	.57,.13	.003,.11					

Table 5	Predictive mode	l results – moc	derated effect	cts of MBCP (on compassion	trajectories
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CS Compassion Scale, Dichotomous predictors (MBCP, Partner) represent 0/1 dummy-codes; continuous predictors represent Z-scores. Significant moderated effects (p <.05) highlighted in bold

and mental health risks, as well as by mindfulness class dosage. MBCP x Cohabiting Partner predicted a higher total CS slope, and MBCP x Age predicted higher Kindness and Mindfulness subscale intercepts. MBCP x T1 CESD depression predicted a lower Mindfulness subscale intercept. Finally, MBCP x Total Class Hours predicted a higher total CS intercept (see Table 5). These effects highlighted better outcomes for MBCP participants with lower sociodemographic risk characteristics and those who engaged more with the class. Region of significance testing showed that for participants with no cohabiting partner, MBCP predicted a lower compassion slope compared to the community class condition; among participants with a cohabiting partner, there were no differences by class condition (see Fig. 4). We also found that for participants reporting at least average class engagement (55 th %ile and above), MBCP predicted higher compassion levels compared to the community class condition (lower bound out of range; see Fig. 5).



Fig. 4 Cohabiting partner moderates the effect of MBCP on compassion—predicted CS trajectories by class condition across timepoints at the boundaries of the region of significance



Fig. 5 Total class hours moderates the effect of MBCP on compassion—predicted CS Trajectories by class condition across timepoints at the boundaries of the region of significance

Table 6Predictive model results – moderated effects of MBCPon mother-infant bonding trajectories

	MA Total		MA Quality of Attachment				
Predictor	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE			
1. MBCP	54,.19	.17,.13	53,.097	087,.097			
Partner	46,.15	086,.048	35,.11	17,.062			
MBCP x Partner	.53,.20	16,.14	.54,.12	.11,.11			
2. MBCP			041,.068	.016,.051			
T1PSWQ			12,.046	12,.032			
MBCP x T1PSWQ			.029,.067	.11,.043			
3. MBCP	.11,.12	078,.063					
Class Hrs	19,.16	.18,.072					
MBCP x Class Hrs	.13,.16	20,.082					

 $\it MA$ Maternal Attachment Scale Dichotomous predictors (MBCP, Partner) represent 0/1 dummy-codes; continuous predictors represent Z-scores Significant moderated effects (p <.05) highlighted in bold

For the bonding outcome, we again found evidence that baseline sociodemographic and mental health risks and mindfulness class dosage moderated MBCP effects. MBCP x Cohabiting Partner predicted a higher total MA intercept (similar but stronger for the Quality of Attachment subscale intercept). MBCP x T1 PSWQ predicted a higher Quality of Attachment subscale slope. Finally, MBCP x Total Class Hours predicted a lower total MA slope (see Table 6). These effects meant better outcomes for MBCP participants who began with lower sociodemographic risk characteristics but greater worry. Region of significance analysis showed that for participants without a cohabiting partner, MBCP predicted lower bonding with their infant compared to the community class condition; for participants with a cohabiting partner, there were no differences by class condition (see Fig. 6). For those with high baseline worry (93rd %ile and above), MBCP predicted a higher quality of attachment slope compared to the community class, but for those with low baseline worry (13 th %ile and below) the opposite was true (see Fig. 7). Finally, for those with greater class engagement (65 th %ile and above) MBCP predicted less of an increase in bonding compared to the community class condition, though this resulted in a similar bonding level by the end of the study period (lower bound out of range; see Fig. 8).

For the mindful parenting outcome (administered only at T3), we did not detect any significant effects on the total IMP-I score. However, we found a moderated effect on the Compassion for Self and Child subscale ($\beta = 0.37$, p = 0.044); participants with higher baseline CS compassion showed a more positive effect of MBCP on this outcome.

When secondary outcomes were examined, postclass mindfulness dosage proved the most consistent moderator. MBCP x Post-Class Practice Hours predicted lower intercepts of CESD and EPDS depression, as well as PSS stress, PSWQ worry, and RRS rumination. These effects highlighted better MBCP outcomes for participants who engaged in more ongoing practice, likely reflecting bidirectional effects (i.e., participants



Fig. 6 Cohabiting partner moderates the effect of MBCP on bonding—predicted MA trajectories by class condition across timepoints at the boundaries of the region of significance



Fig. 7 Baseline worry moderates the effect of MBCP on bonding attachment quality—predicted MA-Q trajectories across timepoints by class condition at the boundaries of the region of significance

who were less distressed may have found it easier to engage in continuing practice). MBCP x Post-Class Practice Hours additionally predicted a lower PSWQ worry slope. Several baseline sociodemographic riskmoderated effects were also evident: MBCP x Cohabiting Partner predicted lower CESD depression and RRS rumination intercepts and slopes, as well as a lower PSS stress slope. Finally, MBCP x Age predicted a lower PSS stress slope. Similarly to the effects on primary outcomes above, these interactions pointed to better outcomes for MBCP participants who began with lower sociodemographic risk characteristics (see Table 7).



Fig. 8 Total class hours moderates the effect of MBCP on bonding – predicted MA trajectories across timepoints by class condition at the boundary of the region of significance

Table 7 Predictive model results – moderated effects of MBCP on distress traject	ories
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	CESD		EPDS		PSS		PSWQ		RRS	
Predictor	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE	Intercept Coeff, SE	Slope Coeff, SE
1. MBCP	.57,.27	.27,.094			.55,.35	.29,.089			.58,.22	.20,.079
Partner	.37,.11	.22,.095			.34,.16	.30,.073			.42,.16	.12,.069
MBCP x Partner	67,.28	33,.11			63,.39	51,.12			74,.25	23,.10
2. MBCP					.013,.15	22,.081				
Age					13,.11	.17,.051				
MBCP x Age					14,.14	20,.088				
3. MBCP	31,.10	035,.072	086,.11	.080,.071	43,.17	15,.097	44,.19	10,.072	33,.13	.002,.083
Post-Class Hrs	1.47,.24	090,.31	.83,.33	40,.29	1.03,.52	50,.40	1.28,.58	15,.16	1.19,.39	25,.37
MBCP x Post-Class Hrs	-1.60,.50	.023,.38	-1.06,.52	.36,.34	-1.74,.74	.12,.49	-1.87,.79	71,.35	-1.69,.54	.075,.41

CESD Center for Epidemiologic Studies Depression Scale, *EPDS* Edinburgh Postpartum Depression Scale, *PSS* Perceived Stress Scale, *PSWQ* Penn State Worry Questionnaire, *RRS* Ruminative Response Scale. Dichotomous predictors (MBCP, Partner) represent 0/1 dummy-codes; continuous predictors represent Z-scores. Significant moderated effects (*p* <.05) highlighted in bold

Discussion

In this study we sought to clarify when and how the impacts of mindfulness intervention extend beyond individual well-being to relational outcomes. We did so by comparing trajectories of mindfulness, compassion, and bonding (primary outcomes) and psychological distress (secondary outcomes) across child-bearers randomized to MBCP or a community childbirth preparation class, examining both main effects of intervention and moderators.

Overall, we found evidence for greater benefits of MBCP among child-bearers with lower baseline risk characteristics, with the exception of anxiety-related worry, as well as among those who engaged more with mindfulness practice both during the class and beyond. These findings which were partially in line with hypotheses—shed further light on the boundary conditions for relational effects of mindfulness and can help to guide recommendations for application of MBCP in different populations.

The only main effect observed for MBCP in this study applied to a secondary outcome, perceived stress. As expected, participants in MBCP reported lower levels of stress post-course compared to their community class counterparts, reinforcing the characterization of mindfulness-based interventions such as MBCP as a "stress reduction" tool. A foundational tenet within such programs is that learning to approach our experiences with openness and non-resistance may not lessen painful aspects of the experience itself, but it can diminish the suffering it brings (the "second arrow" of Buddhist teachings [52]); it is not surprising given this teaching that mindfulness effects would appear in the form of lower perceived stress, consistent with previous research in distressed perinatal populations [34, 35]. It is also possible that greater variability in this measure, compared to most of the others assessed, contributed to detecting a significant effect for this particular outcome. Testing in larger and more variable samples with greater statistical power to detect effects would help to clarify if this is the case.

For our primary outcome domains, there were no significant main effect differences between birthing-people participating in MBCP and those who participated in a community childbirth class; it was only after taking moderators into consideration that significant differences emerged. In line with predictions and with a previous study of mental health trajectories following a condensed version of MBCP [28], we found evidence of greater benefits for participants who began the study with higher levels of anxiety-related worry. This pattern also echoes findings from a larger meta-analytic review of perinatal mindfulness-based interventions for depression and anxiety that revealed stronger effects for those with higher baseline symptom severity [27], while broadening the scope of outcomes beyond mental health to encompass growth in mindfulness and bonding quality with the infant. We further found that trajectories of worry themselves showed MBCP-related improvements with greater ongoing mindfulness practice, highlighting worry as a domain that both differentiates child-bearers for whom this form of training can be most helpful and that is sensitive to practice effects.

On the other hand, we found that baseline depressive symptoms mitigated the effect of MBCP on a component of compassion (the mindfulness subscale), suggesting that distress symptoms may boost or dampen benefits depending on the predominant type of distress involved. It may be that features of MBCP such as gaining comfort with "don't know mind" while clarifying what one does have agency over in a largely uncontrollable process like childbirth are particularly helpful for those prone to anxiety-related worry. Future research might probe further which components of MBCP are most useful for boosting which individual (mental health, mindfulness) and relational (bonding) outcomes in child-bearers with different symptom profiles, but this study reinforces indications that those with higher perinatal anxiety are particularly likely to gain from such programs.

In contrast to the preponderance of effects for baseline mental health risk, sociodemographic risk moderated MBCP in the opposite direction such that participants with greater risk characteristics tended to show poorer outcomes-lower levels and/or less growth in facets of mindfulness, compassion, bonding, and mental healthin the intervention group. This pattern countered our initial predictions and is more in line with a review of other (non-mindfulness-based) perinatal intervention research documenting smaller effects on well-being for younger, single women [53]. This same review found that in prevention study samples who did not begin with elevated symptoms the opposite was true. Our sample may be more representative of the former group in that child-bearers were selected for elevated anxiety; as such, they may have found the task of attempting to engage in a demanding program without a foundation of social resources that come with age-related maturity and/or partnership particularly daunting.

Although most participants in our sample reported being in a committed partner relationship, markedly differing effects for those who did not have a cohabiting partner present highlight important considerations in assessing likely benefits of a program like MBCP. Based on our findings, those child-bearers who had already solidified certain relational capacities through a partnership were best poised to continue building on these capacities—in particular, to sustain ongoing compassion and bonding with their infant across pregnancy-postpartum. It is worth noting that the MBCP structure typically involves participation by both the birthing-person and their partner, and the class emphasizes cultivating a supportive partner relationship to jointly meet the challenges of childbirth and parenting. Child-bearers are encouraged to participate with a partner or other support person (e.g., friend, family member, doula); for those child-bearers whose partner was less involved in their daily lives, partner-oriented elements of the class could have been experienced as alienating and even interfering with intended learning. Although preliminary and in need of further exploration-ideally with qualitative measures to probe experiences associated with partner presence (or absence) in different aspects of birthing people's lives-this finding helps clarify who is most likely to realize gains within the existing MBCP structure, and what adaptations may be necessary to reach a more diverse group of child-bearers in need of support.

Consistent with hypotheses, we also found dosagemoderated effects of MBCP demonstrating greater gains for those who participated more both during the class itself and afterward. Those who spent more time on class content during the intervention period displayed higher compassion, and those who reported ongoing practice at follow-up showed higher levels and/or growth in mindfulness and mental health. These effects speak to the importance of practice engagement for realizing benefits of MBCP and the possibility for lasting gains with continued practice, consistent with Lönnberg and colleagues' [26] finding that mindfulness "continuers" showed sustained effects of MBCP on mindfulness and depression. At the same time, effects of continued practice involving intercepts (as opposed to slopes) likely reflect not a simple one-way effect of mindfulness on distress, but rather a series of bidirectional effects by which mothers whose distress had been alleviated by mindfulness practice were more likely to continue practicing. Indeed, such an upward spiral of mindfulness-related reappraisal and increased positive affect and/or decreased negative affect would be consistent with major theories of processes by which mindfulness shapes well-being, mindfulness to meaning [54] and broaden and build [55, 56]. The present study offers a window into one way to set off such a spiral that could have meaningful long-term benefits for both parent and child. Future research could examine in greater detail the paths by which child-bearer mental health, mindfulness practice, and relational capacity as observed in caregiving interactions can reinforce one another across early parenting.

Seemingly at odds with the above, we found less increase in bonding for MBCP participants who reported greater class engagement compared to those in the community class condition. Further investigation of this effect with region of significance testing suggested this reflected higher levels of bonding and less increase over time among high-engagement MBCP participants, resulting in similar levels compared to community class participants by the end of the study period. Importantly, this moderated effect did not hold for the quality of attachment component of the bonding measure, which appeared most robustly associated with other positive outcomes (i.e., mental health measures, compassion, mindfulness in parenting) across timepoints. To better understand the ways in which mindfulness practice can influence the development of the birther-infant bond and downstream outcomes, it may also be helpful to investigate using different measures of bonding. Previous studies of perinatal mindfulness in relation to bonding have employed differing measures, and part of the variability in effects found may be attributable to distinctions in what exactly comprised researchers' operationalization of "bonding."

A review of available bonding measures concluded that each of the scales in common use suffers from weaknesses in psychometric properties and/or clinical utility [57], and developing measures that better map onto relational processes with meaningful downstream impacts may be necessary to advance research in this domain.

The mindfulness in parenting outcome, which incorporates both individual parent qualities and relations with their infant, did not show either a main effect of MBCP or effects involving primary predicted moderators. We did find a moderated effect involving baseline compassion, such that child-bearers in MBCP who began with higher levels of compassion reported higher compassion for self and child at the final assessment. The failure to detect more robust effects on this outcome, an MBCP target supported in qualitative research [58], may be attributable to features of the current study-in particular, presence of the measure at the final timepoint only, which resulted in low statistical power, and/or the higher-risk (elevated anxiety) nature of the sample. It will be important to test longitudinal effects of mindfulness training on mindfulness in parenting as it develops over time in diverse samples to determine which of these features matters for the development of the parenting relationship. For now, we can tentatively conclude that birthing-people who embark on mindfulness training with a stronger relational orientation may most readily show gains in their parenting.

Limitations of the present study underline areas meriting further investigation. Although we sought to recruit a more socio-demographically diverse sample than has typically been studied in perinatal mindfulness research (with some exceptions [13, 59]) and were able to capture enough variability to begin testing moderating effects of some of these characteristics, the sample was relatively small, limiting power to fully test proposed moderated effects, and the composition of participants remained predominantly White, married, and educated. To realize the aspiration of supporting child-bearers who have few resources for meeting the stresses of bearing and caring for an infant, these interventions must be studied in samples that do not resemble those typically presenting for mindfulness classes, and adaptations must be considered to accommodate their needs. For example, based on current findings regarding presence of a cohabiting partner, a mindfulness class that aids in building prenatal social support without a partner could be critical.

We further note limitations in our ability to probe sources of variability attributable to contextual variations across classes such as shifting impacts of the COVID-19 pandemic, as well as instructor and participant characteristics not assessed here. A post hoc test of differential outcomes between participants assigned to fully remote MBCP classes necessitated by the heart of the pandemic vs. those given an in-person option suggested the latter showed greater post-class mindfulness. Although class format was unrelated to the moderator variables highlighted here, making it unlikely that this feature played a role in the reported effects, this supports the value of continuing to make in person mindfulness training available even as shifts toward remote delivery continue to be widespread. Variations across instructors within both the community and MBCP class conditions regarding depth of expertise and/or skillfulness cultivating healing relationships with birthing couples may have contributed to differences that obscured broader MBCP vs. community class effects. It is also plausible that-despite efforts to reduce biased expectancy effects by framing the study as an investigation of the benefits of different types of birthing classes (rather than a test of mindfulness training superiority) and requiring willingness to be randomized to condition-participants' preconceptions about whether a given class would be beneficial for them played a role in outcomes, and that such expectations varied according to some of the moderators identified here. Future research should further examine these possibilities with more in-depth qualitative assessment of participant experiences both prior to and during birthing classes.

Another area to build is the measurement of relational outcomes; although our inclusion of both relationshipspecific (bonding) and more general (compassion) prosocial measures helped expand the known scope of perinatal mindfulness effects, it will be important to examine relational functioning from multiple angles including behavioral, neurophysiological, and other-report measures with (eventually) child-report. More objective assessment strategies will help alleviate concern with relatively low reliability metrics for some self-report measures in the current study. Finally, the temporal scope must extend to allow investigation of changes in parenting and other relational outcomes across development. Designs that allow researchers to parse the value of prenatal, postnatal, and ongoing pre- through postnatal mindfulness training of varying intensities would be particularly meaningful for distinguishing what is most needed to support child-bearers with different baseline risks.

With these limitations in mind, the current study constitutes a step along the greater path of demonstrating how and when secular mindfulness training strengthens relationality. In particular, the current design addresses an identified need for studies comparing mindfulness intervention compared to active controls on a range of outcomes over time while attending to potential moderating factors [10, 29]. We found evidence that gains in both individual and relational outcomes are most likely for those who begin with lower sociodemographic but higher mental health (anxiety) risks, and who receive a greater dose of mindfulness practice during and following the class. By examining effects in a higher-risk community sample exposed to ecologically valid intervention and comparison class options, we further add to what is known about MBCP performance with a test in real-world conditions outside tight researcher control. This work offers further insight into potential reasons for previous reports of inconsistent mindfulness intervention effects on hypothesized relational outcomes by highlighting moderating factors to consider. Our findings can be used to guide tailoring of existing interventions to those most likely to benefit, as well as adaptations that may help to reach others currently underserved by standard mindfulness interventions.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

HKL and LGD conceptualized and designed the study; KLH helped to develop participant protocols and train research staff to coordinate the project; HKL analyzed and interpreted the data; all authors contributed to writing and approved the final manuscript.

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Data availability

The datasets generated and/or analyzed during the current study are not yet publicly available due to ongoing deidentification and analysis of portions of the data collected but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All procedures were approved by the Institutional Review Board at the University of Illinois Urbana-Champaign (protocol 19461) and the Pennsylvania State University (protocol 19138). Prior to participation, potential participants gave written informed consent to the study.

Consent for publication

No individual person's data are reported.

Competing interests

LGD is an unpaid member of the board of the non-profit Mindful Birthing and Parenting Foundation that provides professional training on the MBCP course. The remaining authors declare that they have no competing interests.

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