Effect of prenatal mindfulness training on depressive symptom severity through 18-months postpartum: A latent profile analysis

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Conflict of Interest
The authors declare no conflicts of interest.

Abstract
Objective We examined whether prenatal mindfulness training was associated with lower depressive symptoms through 18-months postpartum compared to treatment as usual (TAU).

Method A controlled, quasi-experimental trial compared prenatal mindfulness training (MMT) to TAU. We collected depressive symptom data at post-intervention, 6-, and 18-months postpartum. Latent profile analysis identified depressive symptom profiles, and multinomial logistic regression examined whether treatment condition predicted profile.

Results Three depressive symptom severity profiles emerged: none/minimal, mild, and moderate. Adjusting for relevant covariates, MMT participants were less likely than TAU participants to be in the moderate profile than the none/minimal profile (OR = 0.13, 95% CI = 0.03-0.54, p = .005).

Conclusions Prenatal mindfulness training may have benefits for depressive symptoms during the transition to parenthood.

KEYWORDS
latent profile analysis, maternal depressive symptom severity, mindfulness, perinatal depressive symptom severity
Although becoming a parent is often expected to be a time of great joy, a substantial number of women develop depressive symptoms during this transition (Gavin et al., 2005). Point prevalence estimates for elevated depressive symptom severity are 8.1%, 10.1%, and 11.3% at 3-, 6-, and 18-months postpartum, respectively (Woolhouse, Gartland, Mensah, & Brown, 2015). The negative consequences of perinatal depression for maternal and infant health have prompted an array of intervention efforts, and mindfulness-based interventions show promise. A meta-analysis of 17 studies examining mindfulness-based interventions during the perinatal period found significant within-group improvements in depressive symptoms from pre- to post-intervention, but no significant between-group differences in post-intervention symptoms (Lever Taylor, Cavanagh, & Strauss, 2016). None examined depressive symptoms beyond 6-months postpartum, so it is unknown whether benefits are sustained long-term. This is a significant gap in the literature because persistent maternal depression has adverse correlates and consequences for children (Goodman et al., 2011). Thus, understanding the extent to which mindfulness-based interventions contribute to longer-term improvements in maternal depression adds to our understanding of effective treatments and optimal ways to support maternal and child health during the critical early years of life. To this end, the current study examines the association between prenatal mindfulness-based training and depressive symptom severity through 18-months postpartum.

Participants were drawn from a study examining the effects of an 8-week mindfulness-based program on excessive gestational weight gain among overweight or obese, racially and ethnically diverse, predominantly low-income pregnant women (ClinicalTrials.Gov identifier NCT01307683). Overweight, obesity, and excessive weight gain are prevalent problems during pregnancy (Dudenhausen, Grunebaum, & Kirschner, 2015), with important implications for maternal and child health (Gaillard et al., 2013). A core focus of the mindfulness-based intervention was on reducing psychosocial distress in order to prevent excessive gestational weight gain. Previous research suggests that depression may be particularly prevalent among women in this sample. Black and Latina women are at increased risk of prenatal depression compared to non-Hispanic white women, potentially due in part to lower income (Gavin et al., 2011; Rich-Edwards et al., 2006), and women who enter pregnancy overweight or obese have higher odds of depression during pregnancy and the postpartum period (Molyneaux, Poston, Ashurst-Williams, & Howard, 2014). Primary outcome results indicated that the mindfulness-based intervention was associated with significantly greater pre- to post-intervention improvements in depressive symptom severity compared to treatment as usual (TAU; Epel et al., 2016). Subsequent funding to investigate offspring cardio-metabolic risk factors and developmental trajectories provided the opportunity to collect maternal depression data through 18-months postpartum. Thus, in the current follow-up investigation, we examined whether the effect of the prenatal mindfulness intervention on depressive symptom severity endured from post-intervention through 18-months postpartum.

In recognition of prior work demonstrating that perinatal depression is heterogeneous (Putnam et al., 2015), we utilized statistical techniques to explore subpopulations of symptom severity over time. An advantage of this latent profile analysis approach is that it identifies distinct, empirically-defined profiles of depressive symptom severity and elucidates unique symptom courses, predictors, and consequences, in contrast to modeling strategies that assume individuals come from a single, homogenous population (Campbell, Morgan-Lopez, Cox, McLoyd, & NICHD Early Childcare Research Network, 2009). We hypothesized that participants who received mindfulness training would have significantly lower depressive symptom severity from the third trimester of pregnancy through 18-months postpartum compared to participants who received TAU.

2 | METHODS

2.1 | Participants and procedures

Participants were drawn from a study examining effects of an 8-week mindfulness-based program on stress, depression, and excessive gestational weight gain compared to TAU in racially and ethnically diverse, overweight or obese,
predominantly low-income pregnant women (n = 215). Per recommendations from the Obesity-Related Behavioral Intervention Trials model, we utilized a quasi-experimental controlled trial design focused on obtaining a clinically significant signal prior to more rigorous, costly testing using a randomized design (Czajkowski et al., 2015). A subset of study participants agreed to be followed for a subsequent project examining offspring cardio-metabolic risk factors and developmental trajectories. Details of our recruitment strategy have been published (Coleman-Phox et al., 2013; Congdon, Adler, Epel, Laraia, & Bush, 2016).

Study protocols were approved by the institutional review boards at all study sites. Participants provided written informed consent after discussion about study procedures. All procedures were in compliance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Inclusion criteria were: (1) English speaking, (2) pregnant, (3) age 18–45 years, (4) household income < 500% of the federal poverty guidelines ($72,850 for a family of 2 in 2010), and (5) self-reported prepregnancy body mass index $25–41 \text{kg/m}^2$. Exclusionary criteria were: (1) medical conditions that might affect gestational weight gain, (2) current practice of mindfulness meditation more than once per week, (3) multiple gestation, (4) currently taking weight loss drugs, medications for diabetes, antidepressants, antipsychotics, opiate drugs, or corticosteroids, (5) history of gastric bypass surgery, and (6) substance abuse, mental health, or medical condition that would affect metabolism, body composition, or ability to participate in the intervention. Women who were 12–19 weeks gestation and able to attend eight weekly 2-hour classes were eligible to enroll in the intervention (mindful moms training; MMT). Women who were 20–23 weeks gestation or unable to attend MMT classes who otherwise met the study criteria were eligible for TAU. Participants completed study questionnaires at baseline, third trimester of pregnancy (post-intervention for MMT participants, 8–10 weeks after baseline for TAU participants), 6-, and 18-months postpartum.

2.2 | Intervention

2.2.1 | Mindful moms training

MMT was adapted from three interventions: mindful motherhood training (Vieten, 2009), Supporting Health by Integrating Nutrition and Exercise, and Mindfulness-Based Eating Awareness Training (Kristeller & Wolever, 2011). In eight weekly 2-hour sessions, MMT aimed to prevent excessive gestational weight gain in three experiential training components (Vieten et al., unpublished article). The nutrition and eating behavior component focused on supporting healthier eating through discussion of what to eat, how much to eat, and how and when to eat. The mindful eating component fostered awareness of hunger and satiety cues, taste satisfaction, and food choices. The mindfulness for stress reduction component used formal (e.g., sitting meditation) and informal (e.g., mindfulness of daily activities) practices to promote nonreactivity to and nonjudgmental acceptance of negative experiences. For more information about the MMT intervention, see Felder et al. (2017) and Epel et al. (2016).

2.2.2 | Treatment as usual

No restrictions were placed on the mental health care that MMT or TAU participants received during the study period, and participants with elevated depressive symptom severity scores were provided a list of local mental health providers.

2.3 | Measures

2.3.1 | Demographic measures

Participants self-reported their age, race/ethnicity (African American, Latina, Multiracial/Other, or White), marital status (married/committed relationship or single), educational attainment (did not complete high school or completed high school or equivalent), poverty (above or below 100% poverty level), prepregnancy body mass index, parity (nulliparous or multiparous), and gestational age at enrollment in weeks.
2.3.2 Depressive symptom severity

The Patient Health Questionnaire (PHQ-9) is a nine item self-report measure of depressive symptom severity in the previous two weeks (Kroenke, Spitzer, & Williams, 2001), and has been validated in pregnant, predominantly low-income women (Sidebottom, Harrison, Godecker, & Kim, 2012). The PHQ-9 was administered at baseline, third trimester, 6-months postpartum, and 18-months postpartum. Total scores range from 0–27; scores ranging from 1–4 indicate minimal severity, 5–9 indicate mild depression, 10–14 indicate moderate depression, 15–19 indicate moderately severe depression, 20–27 indicate severe depression. Internal consistency was acceptable at all timepoints (Cronbach’s alphas > 0.80).

2.4 Data analysis

Latent Profile Analysis (LPA) is a statistical modeling approach that detects population heterogeneity and identifies discrete subgroups (“profiles”) to which individuals can be assigned based on their presentation (Collins & Lanza, 2010). Participants’ self-reported continuous depressive symptoms at three timepoints during the perinatal period were subjected to LPA to evaluate the presence of underlying profiles differing in symptom pattern. Total number of profiles was determined by considering fit statistics and other model information (e.g., Akaike’s Information Criterion, AIC; Bayesian Information Criterion, BIC; Lo-Mendell-Rubin likelihood ratio test, LMR; Vuong-Lo-Mendell-Rubin likelihood ratio test, VLMR) in combination with prior empirical research (Nylund, Asparoultiov, & Muthen, 2007). LPA estimates the probability of membership in each profile and individuals are ultimately assigned to the profile for which this value is the highest (Muthen & Muthen, 2000). LPA was conducted using MPlus using full information maximum likelihood to handle missing data.

Multinomial logistic regression was conducted in SPSS version 23 to examine the effect of condition (MMT, TAU) on latent profile assignment. To identify relevant covariates, one-way analyses of variance and chi-square tests examined associations between condition and demographic characteristics. There were no significant between-group differences in sociodemographic variables except for gestational weeks at enrollment (mean [M] = 14.81, standard deviation [SD] = 2.62 for MMT vs. M = 19.99, SD = 4.45 for TAU, p < .001), which was adjusted for in multinomial logistic regression models. In order to control for pre-intervention depression levels, and given our focus on exploring the effects of MMT versus TAU on post-intervention latent profile assignment, baseline depressive symptom severity was also included as a covariate.

3 RESULTS

3.1 Participant characteristics

Participant flow has been described previously (Epel et al., 2016). Of 215 enrolled participants, 110 were assigned to MMT and 105 to TAU. Profile data were not computed for 24 participants (n = 13 MMT) missing PHQ-9 data from post-intervention, 6-months postpartum, and 18-months postpartum. The final analytic sample included 191 participants (n = 97 MMT). Compared to excluded participants, a higher proportion of participants in the final analytic sample were multiparous (55.5% vs. 29.4%, p = .039). There were no differences in sociodemographic variables or baseline depression. On average, participants were 27.90 years old (SD = 5.84), had a prepregnancy body mass index of 30.73 (SD = 4.73), and were 17.40 weeks pregnant (SD = 4.48) at enrollment. The majority was African American (40.19%, n = 86), followed by Latina (28.97%, n = 62), Other/Multiracial (17.29%, n = 37), and White (13.55%, n = 29). Less than half were nulliparous (44.50%, n = 85), the majority was married or in a committed relationship (68.22%, n = 46), and had completed high school or equivalent (87.91%, n = 189), and nearly half were at or below the 100% poverty level (47.64%, n = 91). In 2010, 100% of the federal poverty level for a family of two was $14,570.
### Table 1  Fit statistics for latent profile analysis of perinatal depression severity

<table>
<thead>
<tr>
<th>Sample size</th>
<th>1 Profile</th>
<th>2 Profile</th>
<th>3 Profile</th>
<th>4 Profile</th>
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<td>40</td>
<td>34</td>
</tr>
<tr>
<td>Profile 2</td>
<td>103</td>
<td>50</td>
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<tr>
<td>Profile 3</td>
<td>101</td>
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<td></td>
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<tr>
<td>Profile 4</td>
<td>25</td>
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<table>
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<tr>
<th>Fit statistics</th>
<th>1 Profile</th>
<th>2 Profile</th>
<th>3 Profile</th>
<th>4 Profile</th>
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</thead>
<tbody>
<tr>
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<td>2376.88</td>
<td>2374.66</td>
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<td>BIC</td>
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<td>2468.27</td>
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<td>0.70</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
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<td>.04</td>
<td>.38</td>
<td>.37</td>
</tr>
<tr>
<td>Vuong-LMR LRT p-value</td>
<td>.001</td>
<td>.037</td>
<td>.37</td>
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</table>

Note. For the final three-profile model, profile 1 is labeled “none/minimal depressive symptom severity,” profile 2 is labeled “moderate depressive symptom severity,” and profile 3 is labeled “mild depressive symptom severity.” AIC = Akaike Information Criterion, lower numbers are better; BIC = Bayesian information criterion, lower numbers are better; Entropy: ranges from 0–1, higher numbers are better; LMR Adjusted LRT = Lo-Mendell–Rubin adjusted likelihood ratio test, want $p < .05$.

### 3.2 Depressive symptom severity profiles

One, two, three, and four-profile solutions were evaluated with LPA. Results indicated that a three-profile model provided a better fit to the data than the one- and two-profile solutions, as indicated by lower AIC and BIC values and significant LMR and VLMR likelihood ratio tests. Although the four-profile model provided a lower AIC and higher entropy, the non-significant LMR and VLMR likelihood ratio tests in combination with consideration of parsimony led to our conclusion of the three-profile solution as final (Table 1). Because the graph of depression profile means suggested growth within the moderate profile, we conducted a latent profile growth analysis (LPGA). Linear growth terms for all profiles were not significant, indicating that depressive symptom severity within profiles remained stable from the third trimester of pregnancy through 18-months postpartum. Thus, subsequent analyses proceeded with three profiles identified by LPA representing none/minimal depressive symptom severity, mild depressive symptom severity, and moderate depressive symptom severity (Figure 1).

There were 20.9%, 52.9%, and 26.2% participants in the none/minimal, mild, and moderate profiles, respectively. Across the three timepoints, average PHQ-9 scores were 0.95 (SD = 0.73), 4.28 (SD = 1.53), and 10.23 (SD = 2.76) for the none/minimal, mild, and moderate profiles, respectively.

### 3.3 Intervention effect on perinatal depressive symptom severity profile membership

The mild and moderate depressive symptom severity profiles were compared to the none/minimal depressive symptom severity profile. Adjusting for baseline depression and gestational age at enrollment, participants had lower odds of being in the moderate depressive symptom severity profile than the none/minimal profile if they were in the MMT group (odds ratio = 0.13, 95% confidence interval = 0.03–0.54, $p = .005$). Said conversely, a participant had 7.80 greater odds of being in the moderate depressive symptom severity profile if they were in the TAU group. A similar trend was observed for membership in the mild profile relative to the none/minimal profile. Adjusting for baseline depressive symptom severity and gestational age at enrollment, participants trended toward lower odds of being in the mild depressive symptom severity profile than the none/minimal profile if they were in the MMT group (odds ratio = 0.33, 95% confidence interval = 0.09–1.20, $p = .092$). Said conversely, a participant had 3.01 greater odds of being in the mild depressive symptom severity profile if they were in the TAU group.
FIGURE 1  Depression symptom severity means and standard error of the mean for each timepoint by profile
Note. The number of participants classified as none/minimal, mild, and moderate were 40 (20.9%), 101 (52.9%), and 50 (26.2%), respectively. Nonsignificant growth terms in a latent profile growth analysis (LPGA) indicate that depressive symptom severity within profiles remained generally stable from the third trimester of pregnancy through 18-months postpartum.

4 | DISCUSSION

The present study identified three distinct, empirically-defined subgroups of depressive symptom severity during the perinatal period (i.e., none/minimal, mild, and moderate), consistent with previous research documenting the heterogeneity of perinatal depression. Across the period of time spanning from the third trimester of pregnancy through 18-months postpartum, women who received prenatal mindfulness training were less likely to be in the moderate depressive symptom severity profile compared to women who received TAU. This study represents the longest examination of the effects of a prenatal mindfulness program that we are aware of, and shows that benefits for maternal psychological health were sustained beyond the first postpartum year.

Null findings from an LPGA suggest that depressive symptom severity within profiles remained generally stable from the third trimester of pregnancy through 18-months postpartum, consistent with previous work through 12-months postpartum (McCall-Hosenfeld, Phiri, Schaefer, Zhu, & Kjerulff, 2016). Notably, over 25% of participants in the current study were classified in the moderate depressive symptom severity subgroup. This rate is higher than previously reported point prevalence estimates during pregnancy and through 18-months postpartum (Woolhouse et al., 2015), and provides further evidence that the women who comprised the present sample may be at heightened risk for perinatal depression. Further, results underscore the importance of screening for and treating perinatal depression early, ideally during pregnancy.

There may be several mechanisms by which prenatal mindfulness training may protect women from depressive symptoms during the transition to parenthood. It is possible that learning to respond skillfully to stressful life events (e.g., with acceptance and nonreactivity) may break the stress–depression cycle previously observed among disadvantaged mothers (Pianta & Egeland, 1994). In light of meta-analytic evidence linking home practice with outcomes in mindfulness-based interventions (Parsons, Crane, Parsons, Fjorback, & Kuyken, 2017), future research should investigate the extent to which the benefits of prenatal mindfulness training depend on sustained, regular practice during and after the intervention. Additionally, the group-based intervention format may have indirectly targeted many of the barriers to help-seeking previously identified among low-income, ethnic minority perinatal women (Abrams, Dornig, & Curran, 2009), such as stigma, low social support, and lack of knowledge about depression. Thus, participants who received prenatal mindfulness training may have been more likely to seek formal or informal help for depressive symptoms compared to women who received usual care.
The mindfulness-based intervention under investigation targeted psychosocial distress with the goal of preventing excessive gestational weight gain among overweight and obese pregnant women. Although the generalizability of our results to pregnant women who are not overweight or obese is limited, it should be noted that our sample characteristics are increasingly representative of pregnant women in the United States. Notably, 66.2% of adult females in the United States are overweight or obese, and rates are higher among ethnic minority women (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016; National Center for Health Statistics, 2017). Additionally, 48% of women begin pregnancy either overweight or obese (Dudenhausen et al., 2015).

The current study did not examine depression diagnoses using a clinical interview, relying instead on well-validated self-report measures of depressive symptom severity. It is important to note that the PHQ-9 has high clinical utility due to its brevity and it has been validated against the Structured Clinical Interview for DSM-IV (SCID). Compared to the SCID, the PHQ-9 has high sensitivity (85%) and specificity (84%) in pregnant women, and at least 80% sensitivity in postpartum women (Davis, Pearlstein, Stuart, O’Hara, & Zlotnick, 2013; Sidebottom et al., 2012). The study from which participants were drawn was an early proof of concept pilot study of efficacy, and thus did not utilize random assignment to condition, limiting our ability to make causal inferences (Czajkowski et al., 2015).

4.1 Conclusions

We previously found that a mindfulness intervention led to short-term reductions in depressive symptoms during pregnancy (Epel et al., 2016). The current analyses show that these benefits remained evident through 18-months postpartum. Ongoing work is needed to examine pathways through which mindfulness interventions support women during the transition to parenthood and possible downstream benefits for children’s health and well-being.

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REFERENCES


