Published in final edited form as:

Nurs Res. 2020 ; 69(1): 82–88. doi:10.1097/NNR.0000000000000382.

Protocol for pilot study on self-management of depressive symptoms in pregnancy

Patricia Kinser, PhD, WHNP-BC, RN, FNAP, FAAN [Associate Professor],

Virginia Commonwealth University School of Nursing, Richmond, VA

Sara Moyer, RN [Research Nurse],

Virginia Commonwealth University School of Nursing, Richmond, VA

Suzanne Mazzeo, PhD [Professor],

Virginia Commonwealth University Department of Psychology, Richmond, VA

Timothy P. York, PhD [Associate Professor],

Virginia Commonwealth University School of Medicine, Richmond, VA

Ananda Amstadter, PhD [Associate Professor],

Virginia Commonwealth University School of Medicine, Richmond, VA

Leroy Thacker, PhD [Associate Professor],

Virginia Commonwealth University Department of Biostatistics, Richmond, VA

Angela Starkweather, PhD, ACNP-BC, CNRN, RN, FAAN [Professor]

University of Connecticut School of Nursing, Storrs, CT

Abstract

Background—Pregnant women with depressive symptoms face significant treatment challenges, and are in great need of safe, effective, accessible, inexpensive, and nonpharmacologic self-management therapies to enhance well-being, reduce the burden of symptoms both during their pregnancy and postpartum, and prevent chronic sequelae.

Objectives—In this paper, we describe the protocol for our pilot study testing a self-management intervention entitled, “Mindful Moms,” designed to foster women’s ability to address current depressive symptoms and enhance resilience to prevent recurrence.

Corresponding author: Patricia A. Kinser, PhD, WHNP-BC, RN, FNAP, FAAN, Virginia Commonwealth University School of Nursing, 1100 E. Leigh St., Richmond, VA 23298 (kinserpa@vcu.edu).

Patricia A. Kinser, PhD, WHNP-BC, RN, FNAP, FAAN is an Associate Professor and **Sara Moyer, RN**, is a Research Assistant at the Virginia Commonwealth University School of Nursing.

Suzanne Mazzeo, PhD, is a Professor at the Virginia Commonwealth University Department of Psychology.

Timothy P. York, PhD, and **Ananda Amstadter, PhD**, are Associate Professors at the Virginia Commonwealth University School of Medicine.

Leroy Thacker, PhD, is an Associate Professor at the Virginia Commonwealth University Department of Biostatistics.

Angela Starkweather, PhD, ACNP-BC, CNRN, RN, FAAN, is a Professor at the University of Connecticut College of Nursing.

The authors have no conflicts of interest to report.

Ethical Conduct of Research: This study was approved by the Virginia Commonwealth University Institutional Review Board.

Clinical Trial Registration: The trial was registered at clinicaltrials.gov (NCT02953990; “Self-management of chronic depressive symptoms in pregnancy”; <https://clinicaltrials.gov/ct2/show/NCT02953990?term=NCT02953990&draw=1&rank=1>; 11/3/16).

Methods—We will conduct a longitudinal pilot trial of the 12-week intervention with pregnant women with depressive symptoms ($n = 40$); the primary aim is to determine the feasibility and acceptability of the intervention. The secondary aim is to examine preliminary effects of the intervention on maternal psychobehavioral outcomes in pregnancy and 6-weeks postpartum. The third aim will quantify genome-wide and gene-specific DNA methylation patterns associated with depressive symptoms during pregnancy and investigate whether intervention participation influences these patterns.

Results—This study is currently ongoing.

Discussion—Findings from this study will inform future research addressing the need for nonpharmacologic self-management interventions for pregnant women with depressive symptoms.

Keywords

pregnancy; self-management; DNA methylation; depressive symptoms

The development of safe, effective, nonpharmacological treatments for depressive symptoms during pregnancy is an urgent public health priority. Nearly 20% of pregnant women experience clinically significant depressive symptoms (American College of Obstetricians and Gynecologists [ACOG], 2018). Although there are numerous pharmacological treatments available for depressive symptoms, data regarding their safety during pregnancy are conflicting, and little research has addressed the efficacy of nonpharmacological therapies in this population (Epstein, Moore, & Bobo, 2014). Hence, many women with depressive symptoms remain untreated or undertreated. Untreated or undertreated depressive symptoms are associated with a variety of poor maternal–child outcomes, from maternal suicide and postpartum depression to impaired fetal and infant health (ACOG, 2018; Gentile, 2017).

In an effort to address this need, we will pilot a self-management intervention entitled “Mindful Moms” which has three key components: (a) a nurse–participant partnership to foster awareness of depressive symptoms and goal-setting for symptom management through motivational interviewing; (b) mindful physical activity through 12 weeks of instructor-led group prenatal yoga classes; and (c) self-directed, home-based, mindful physical activity. This approach builds on preliminary work that demonstrated pregnant women with depressive symptoms desire an active role in symptom management and viewed yoga as an accessible, preferred form of physical activity (Kinser, Bourguignon, Whaley, Hauenstein, & Taylor, 2013; Kinser, Goehler, & Taylor, 2012).

This longitudinal pilot study has the following aims: For Aim 1, we will evaluate the feasibility and acceptability of Mindful Moms by exploring recruitment, retention, satisfaction, and adherence data during the 12-week prenatal intervention and at a 6-week postpartum visit, and evaluating participants’ experiences after the intervention with a semi-structured interview at the postpartum visit. For Aim 2, we will examine the preliminary effects of Mindful Moms on maternal psychosocial measures (i.e., depressive symptoms, anxiety, stress, ruminations, self-efficacy, maternal–child attachment) at baseline, midpoint, and end of the 12-week intervention, and at 6-weeks postpartum; these data will be

compared with that of an archival comparison group of pregnant women with and without depressive symptoms receiving usual care. For Aim 3, we will identify genome-wide and gene-specific DNA methylation (DNAm) patterns associated with chronic depressive symptoms during pregnancy and investigate their relation to participation in the intervention, as compared to an archival control group. It has been hypothesized that DNA-based changes might mediate the effects of interventions addressing depressive symptoms in pregnant women (Guintivano, Arad, Gould, Payne, & Kaminsky, 2014; Kimmel, Kaminsky, & Payne, 2013). DNAm appears to be responsive to environmental and physiological changes, and thus has recently been of interest as a mechanism by which interventions yield effects (Hompes et al., 2013; Yehuda et al., 2013). Given that this is a pilot study, no specific hypotheses are proposed.

Methods

Study Design

This longitudinal intervention study uses a repeated measures design, coupled with qualitative methods, to provide a comprehensive view of the feasibility, acceptability, and preliminary effects of the Mindful Moms intervention. Recruitment and retention numbers and semi-structured interviews will be used to evaluate feasibility and acceptability (Aim 1) of the intervention. Recently collected archival comparison group data from an existing study will be used to contribute to explorations of preliminary effects of the intervention by comparing longitudinal psychobehavioral data (Aim 2) and genome-wide and gene-specific DNAm data (Aim 3). The conceptual framework on which this study is based (illustrated in Figure 1) builds upon the biobehavioral nursing research model developed by McCain and Smith (1994), as well as our previously published conceptual framework about depressive symptoms in women (Kinser & Lyon, 2014).

Setting and Sample

The Mindful Moms study is funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (R15HD086835) and is approved by the Virginia Commonwealth University Institutional Review Board. Forty pregnant women up to 28 weeks gestation will be recruited from local obstetric clinics and the community to participate in the intervention. Eligibility criteria include women who: (a) are no more than 28 weeks gestation at the baseline visit; (b) age 18; (c) self-report depressive symptoms prior to pregnancy; (d) report current depressive symptoms at a moderate-to-severe level, as defined by a score ≥ 10 on the Patient Health Questionnaire (PHQ9); (e) are able to read, write, and understand English; (f) self-identify as Black or White (to match demographics of archival data used for comparison groups); (g) do not endorse suicidal ideation, psychosis, or mania; (h) do not report pregnancy complications/physical conditions making physical activity inadvisable; and, (i) have not engaged in a consistent mindfulness-based physical activity routine during the current pregnancy (e.g., yoga or similar activities more than once per month). Participants who deliver via cesarean section are not excluded from the study because no physical activity is required during the postpartum period of the study. Archival data from an existing observational study include pregnant women who did not receive an intervention; yet, were followed throughout their pregnancies and postpartum. Inclusion

criteria for that study, which occurred in years 2013–2018, are reported elsewhere (Lapato et al., 2018); briefly, the study included generally healthy Black and White pregnant women. The de-identified data will be used to form two comparison groups: (a) positive comparison group ($n = 40$): Pregnant women with clinically relevant depressive symptoms receiving usual care; and, (b) negative comparison group ($n = 40$): Pregnant women without depressive symptoms. The proposed sample size is expected to yield reasonably Si preliminary data, based on van Belle's assertion that a minimum of 12 observations should be used to calculate confidence intervals based on the t -statistic with $n - 1$ degrees of freedom. This rule is based on the fact that the half-width confidence interval for the mean decreases rapidly up to $n = 12$, at which point the decrease is less dramatic and the half-width curve begins to asymptotically decrease (van Belle, 2002). Further, we determined this sample size would be adequate to address the expected 20–40% attrition rate observed in studies with individuals experiencing depressive symptoms (Kinser et al., 2013; Kinser, Elswick, & Kornstein, 2014).

Intervention

Mindful Moms is manualized to optimize intervention fidelity. It incorporates key components informed by the self-management (Bilsker, Goldner, & Anderson, 2012; Lorig & Holman, 2003) and physical activity literature (Whaley, 2004), as well as other research about the acceptability of yoga as a mode of mindful physical activity for pregnant women (Kinser & Masho, 2015). Upon study entry, participants will meet with the research nurse to: (a) discuss self-management concepts; (b) review the importance of gaining self-awareness of depressive symptoms and developing tools to manage those symptoms; and (c) develop personalized "SMART" (specific, measurable, attainable, realistic, and timely) goals related to symptom self-management using aspects of motivational interviewing (Bovend'Eerd, Botell, & Wade, 2009). Participants will then begin a 12-week, community-based, weekly manualized prenatal yoga class, taught by experienced yoga teachers familiar with teaching yoga-naïve and pregnant individuals and trained by the principal investigator (PI)—a certified prenatal yoga instructor. ACOG guidelines for prenatal exercise will be assessed at the beginning of each class and with weekly telephone calls to participants. These guidelines advise cessation of activity if a participant experiences severe symptoms, such as new vaginal bleeding, dizziness, increased shortness of breath, chest pain, severe headache, new muscle weakness, calf pain or swelling, consistent painful uterine contractions, decreased fetal movement, or fluid leaking from the vagina (ACOG, 2011). Participants will be encouraged to apply self-management skills to engage in home-based physical activity, using a handbook of yoga poses practiced during the intervention group sessions and suggestions for other activity (e.g., walking, stair climbing, dancing, among others). Participants will track time spent in home-based physical activity on a provided form and will verbally report this time to the research staff on a weekly basis.

Measures and Data Collection

After obtaining informed consent, data collection will begin at the baseline visit and progress throughout the pregnancy and into postpartum. To minimize participant burden, all measures used in this study are short, appropriate to 6th grade or lower reading level, and

easily self-administered, with well-established reliability and validity (Logsdon & Hutti, 2006).

Demographics and individual/environmental measures—A study-specific demographic and health history form will be administered at the baseline visit including questions about age, socioeconomic status, educational attainment, demographics, current use of treatments for depressive symptoms, current and past medical history, number of lifetime depressive episodes, and current major life events. Social support will be measured with the MOS Social Support Survey (MOS; Sherbourne & Stewart, 1991) which assesses emotional, tangible, affectionate, and positive social interactions. With a possible score of 20–100, a higher score on the MOS represents more social support. A history of major life stresses in the form of traumatic events will be measured with the Trauma History Questionnaire (THQ; Green, 1996; Hooper, Stockton, Krupnick, & Green, 2011). The 24-item THQ is an inventory of potentially traumatic events associated with increased risk for depressive symptoms; the THQ generates a total score representing the numbers and types of traumatic events experienced by the individual.

Feasibility and acceptability measures (Aim 1)—Recruitment and retention success, and adherence to the intervention, will be measured by numbers of individuals eligible to participate; number who consent to participate; attendance rosters for the group classes (to assess feasibility and acceptability of weekly classes); and reported minutes of time in physical activity at home. Semi-structured interviews will contribute qualitative data to provide a comprehensive view of participants' lived experiences with the intervention (Cohen, Kahn, & Steeves, 2000), including a descriptive component focused upon its feasibility, acceptability, and perceived effects (Sandelowski, 2000). Interviews will be conducted at the postpartum visit with open-ended questions about participants' symptoms, their experiences with the intervention, and use of self-management skills during pregnancy and postpartum. The postpartum visit is designed to be synchronous with the recommended postpartum obstetric visit schedule—to minimize participant burden and maximize feasibility of timely assessment. If a participant drops out of the study at any time, she will be contacted and asked to participate in an interview with open-ended questions intended to elicit her reasons for attrition and her experience with the intervention.

Maternal psychosocial measures (Aim 2)—(a) *Depressive symptom severity:* Depressive symptom severity will be evaluated using the Patient Health Questionnaire (PHQ-9), a widely used instrument which has been validated during pregnancy (Sidebottom, Harrison, Godecker, & Kim, 2012). The PHQ-9 includes self-report items regarding depressive symptoms over the past two weeks. Total scores range from 0–27: 0–4 indicates minimal depression; 5–9 mild depressive symptoms; 10–14 moderate depressive symptoms; 15–19 moderately severe depressive symptoms; and 20 severe depressive symptoms. For analysis purposes, presence of depressive symptoms will be defined as a score ≥ 10 on the PHQ9. The PHQ-9 includes a question on suicidal ideation, which will be used for screening for eligibility (excluded if endorse suicidal ideation at baseline) and monitoring potential adverse events. If an individual endorses suicidality during the study, the research team will engage a safety protocol which involves further assessment of suicidality with the MINI

Psychiatric Inventory, discussion with the PI (who is a nurse practitioner), and referral to a healthcare provider and/or immediate placement in care at an emergency department, depending upon suicidality level. Because the archival comparison group database includes the Edinburgh Postnatal Depression Scale (EPDS) in the pregnancy and postpartum assessment, we will also administer this survey at the same timepoints. The EPDS is a widely used and validated measure of depressive symptoms, with 10 questions appropriate for the prenatal and postpartum woman; a score ≥ 10 (range 0–30) suggests possible depressive symptoms (Cox, Holden, & Sagovsky, 1987). (b) *Stress*: The Perceived Stress Scale-10 (PSS-10), a widely used, psychometrically sound instrument, and will be used to assess the degree to which a participant perceives stress in her life during the past month (Cohen, 1994; Cohen, 1988). The PSS-10 asks respondents to report about feelings such as unpredictability, uncontrollability, and overloading of stress in their lives; scores range from 0–40; higher scores correspond to a higher perceived stress level. (c) *Anxiety*: Current levels of anxiety (“state anxiety”) will be evaluated with the State-Trait Anxiety Inventory, Form Y (STAI; Tilton, 2008). This study focuses specifically on state anxiety, as this score is sensitive to women’s anxiety during pregnancy and is more likely to demonstrate change within an intervention period (Newham, Westwood, Aplin, & Wittkowski, 2012). The STAI scores range from 20–40, with higher scores representing higher state anxiety. (d) *Rumination*: Rumination, or repetitive self-critical thinking, will be evaluated with the 10-item Ruminative Responses Scale (RRS) which assesses the propensity to ruminate in association with sadness or depression. A psychometrically sound and widely used instrument, the RRS asks respondents to rate how often they experience various aspects of rumination (Treyner, Gonzalez, & Nolen-Hoeksema, 2003). The RRS has two factors of brooding (self-critical pondering) and reflecting (emotionally neutral pondering or brainstorming). (e) *Self-Efficacy for Physical Activity*: The Physical Activity Self-Efficacy Scale (PASES; Dishman et al., 2010; Motl et al., 2000) is an eight question scale which contains items about self-management of physical activities and social support regarding physical activity. This psychometrically sound scale was selected because of its specific focus on self-management of physical activity. Originally designed for adolescents, the wording has been slightly adapted for an adult sample. (f) *Maternal-Fetal/Child Attachment*: The Maternal-Fetal Attachment Scale (Cranley, 1981) assesses the extent to which women have an affiliation and interaction with their unborn child (during pregnancy) and their infant (during postpartum).

Maternal biological measure (Aim 3)—Peripheral blood specimens will be collected at baseline (up to 28 weeks gestational age) and at the end of intervention week 12 (approximately gestational age of 24–40 weeks) for DNAm analysis. Blood samples will be collected by the study staff and DNA extraction done by the in-house lab, then sent to an external lab for DNA methylation assays. Genome-wide methylation patterns will be determined using the 850K HumanMethylation Chip (Illumina) according to the vendor’s protocol. To verify the results of the array for targeted regions of interest, single loci methylation-sensitive studies of bisulfite converted DNA will be conducted using standard methods (Kaminsky, Assadzadeh, Flanagan, & Petronis, 2005).

Data Analysis

For Aim 1 (feasibility and acceptability of the intervention), data related to recruitment, retention, and intervention adherence will be analyzed using descriptive techniques, including percentages and means. The number of participants who complete each timepoint will be recorded and percentages of the following calculated: persons eligible to participate; persons who signed a consent form; and sessions attended, home activity participation, and participant attrition. Reasons for attrition will be described. Participants' use of yoga and other activity in the group and home setting will be quantified by totaling the number of minutes in activity over 12 weeks, using the group class rosters and report of home practice. A phenomenological data analysis lens with a descriptive component will be used to analyze the qualitative data from the semi-structured interviews. The data collected will be analyzed in the manner of a hermeneutic circle, in which an iterative stepwise analysis is used (Cohen et al., 2000). The authors will independently and collaboratively read all individual interview transcripts to get an overall sense of the data, group quotes into categories based upon similarities, reread the data, and ultimately identify themes to examine and interpret. The themes that arise will be used to construct a coherent picture of participants' lived experiences with the intervention for self-management of depressive symptoms.

For Aim 2, we will examine the potential effects of the intervention on measures of maternal psychological symptoms assessed at multiple timepoints (Figure 2). Means, variances, and covariances/correlations along with 95% confidence intervals for each of the three groups (intervention [Mindful Moms], comparison group with depressive symptoms [positive], and comparison group without depressive symptoms [negative]) will be calculated for each of the four study timepoints (baseline [BL]), IW6, IW12, postpartum [PP]). A mixed linear model will be fit to the data. The model will include one between-subjects effect (Group: intervention, positive comparison, negative comparison), one within-subject effect (Time: BL, IW6, IW12, PP), and the interaction between group and time. This model will allow estimation of changes from baseline in levels of psychological symptoms within and between groups at each timepoint. Possible covariates, such as the initiation of usual care (e.g., medications, psychotherapy), will be fully explored during analysis. Data from participants who drop out of the intervention will be retained in the analytical portion of the study according to intent-to-treat principles. Figure 2 summarizes data collection timepoints for the study in relation to the archival comparison group database. Study data will be analyzed using statistical packages as appropriate (e.g., SPSS, SAS, JMP, and R). Although there is risk of type 1 error due to the number of variables, we do not intend to test hypotheses, and our analysis is focused on generating appropriate preliminary data to support larger-scale studies, as warranted (Moore, Carter, Nietert, & Stewart, 2011).

For Aim 3, we will explore DNAm patterns associated with chronic depressive symptoms during pregnancy and investigate whether participation in the Mindful Moms intervention has an effect on these patterns. Output from the 850K DNA methylation platform will be screened for process errors to ensure that the resultant data pass quality control standards (based on known sites having constant methylation, including genes influenced by X-inactivation) and then processed using the minfi Bioconductor package in the R programming environment (Aryee et al., 2014). Although there is yet no established

standard for the analysis of data from this platform, best practice recommendations will be followed (Bock, 2012; Michels et al., 2013; Wright et al., 2016). CpG sites having a false discovery rate (FDR) < 0.05 will be considered significant. Sites recognized as differentially methylated will be evaluated using a suite of bioinformatic tools—such as the DAVID Functional Classification software program—to identify biological systems and/or functions that are consistently altered. Specifically, we will: (a) assess genome-wide DNAm pattern differences between the nonintervention archival comparison groups: positive comparison and negative comparison over time (4 timepoints), using growth modeling methods; (b) identify within-group genome-wide DNAm pattern differences over time (pre/post the intervention) using paired *t*-tests; and (c) estimate the group x time interaction, identify overlapping DNAm differences among the three groups, and prioritize CpG sites to further evaluate based upon specific candidate genes that have received attention in the literature in relation to depressive symptoms and mindfulness-based interventions, described previously.

Discussion

There are two possible limitations of this study. First, we anticipate that the lack of an active concurrent control group may present challenges regarding statistical conclusion and internal study validity. However, as this is a pilot trial, our primary interest is in feasibility and acceptability of the intervention. If Mindful Moms proves feasible and acceptable, a control group will be added in a larger follow-up randomized controlled trial. Second, this study includes the examination of DNAm which is not commonly studied in relation to self-management interventions; though, the goal of these exploratory analyses is to determine whether DNAm patterns predict treatment response and whether the intervention has targeted DNAm differences identified in the steps outlined above. Findings from this aim will provide important preliminary data for future explorations of DNAm involved in depressive symptom treatment response (Menke & Binder, 2014).

Despite these possible limitations, this novel intervention study provides an exciting opportunity to examine the contribution of potential psychosocial and biological mechanisms involved in depressive symptomatology in pregnant women, and to learn whether a low-cost, self-management intervention may have preliminary psychosocial and DNAm effects. It is clear that depressive symptoms in pregnancy are a problem with public health significance and effective nonpharmacologic treatments are not yet well-established. This study will be one of the first to evaluate the feasibility, acceptability, and potential effects of a self-management approach for depressive symptoms during pregnancy within a multifaceted biobehavioral context, evaluating behavioral and biological (DNAm) outcomes. The results will provide important preliminary information for the development of future randomized controlled studies of interventions that may challenge the clinical paradigm for prenatal care of women with depressive symptoms.

Acknowledgement

Research reported in this publication was supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development under Award R15HD086835-01A1 (PI: Kinser); by the Brain and Behavior Research Foundation NARSAD Independent Investigator Grant (PI: York); by the American Nurses Foundation Research Grant 5232 (PI: Kinser); by the National Institute on Minority Health and Health Disparities Award 5P60MD002256-06 (PI: York); and by CTSA Award UL1TR002649 from the National Center for Advancing

Translational Sciences. Dr., Amstadter's time is partially supported by NIAAA K02-023239. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The authors wish to acknowledge the following individuals for their important contributions to this study: Amy Rider, RN; Christine Aubry, RN; and, Nastassya Russell, RN.

References

- American College of Obstetricians and Gynecologists. (2011). Exercise during pregnancy: Frequently asked questions (FAQ0119). Retrieved from <http://www.acog.org/~media/ForPatients/faq119.pdf?dmc=1&ts=20130711T0951470606>
- American College of Obstetricians and Gynecologists. (2018). ACOG Committee opinion no. 757: Screening for perinatal depression. *Obstetrics and Gynecology*, 132, e208–e212. doi:10.1097/AOG.0000000000002927 [PubMed: 30629567]
- Aryee MJ, Jaffe AE, Corrada-Bravo H, Ladd-Acosta C, Feinberg AP, Hansen KD, & Irizarry RA (2014). Minfi: A flexible and comprehensive Bioconductor package for the analysis of Infinium DNA methylation microarrays. *Bioinformatics*, 30, 1363–1369. doi:10.1093/bioinformatics/btu049 [PubMed: 24478339]
- Bilsker D, Goldner EM, & Anderson E (2012). Supported self-management: A simple, effective way to improve depression care. *Canadian Journal of Psychiatry*, 57, 203–209. doi: 10.1177/070674371205700402 [PubMed: 22480584]
- Bock C (2012). Analysing and interpreting DNA methylation data. *Nature Reviews Genetics*, 13, 705–719. doi:10.1038/nrg3273
- Bovend'Eerd TJ, Botell RE, & Wade DT (2009). Writing SMART rehabilitation goals and achieving goal attainment scaling: A practical guide. *Clinical Rehabilitation*, 23, 352–361. doi: 10.1177/0269215508101741 [PubMed: 19237435]
- Cohen MZ, Kahn DL, & Steeves RH (2000). *Hermeneutic phenomenological research: A practical guide for nurse researchers*. Thousand Oaks, CA: Sage Publications, Inc.
- Cohen S (1994). Perceived Stress Scale. Retrieved from www.mindgarden.com/docs/PerceivedStressScale.pdf
- Cohen S (1988). Perceived stress in a probability sample of the United States In Oskamp S & Spacapan S (Eds.), *The social psychology of health: The Claremont Symposium on applied social psychology*. (pp. 31–67). Thousand Oaks, CA: Sage Publications, Inc.
- Cox JL, Holden JM, & Sagovsky R (1987). Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *British Journal of Psychiatry*, 150, 782–786. doi: 10.1192/bjp.150.6.782
- Cranley MS (1981). Development of a tool for the measurement of maternal attachment during pregnancy. *Nursing Research*, 30, 281–284. doi:10.1097/00006199-198109000-00008 [PubMed: 6912989]
- Dishman RK, Hales DP, Sallis JF, Saunders R, Dunn AL, Bedimo-Rung AL, & Ring KB (2010). Validity of social-cognitive measures for physical activity in middle-school girls. *Journal of Pediatric Psychology*, 35, 72–88. doi:10.1093/jpepsy/jsp031 [PubMed: 19433571]
- Epstein RA, Moore KM, & Bobo WV (2014). Treatment of nonpsychotic major depression during pregnancy: Patient safety and challenges. *Drug, Healthcare and Patient Safety*, 6, 109–129. doi: 10.2147/DHPS.S43308
- Gentile S (2017). Untreated depression during pregnancy: Short- and long-term effects in offspring: A systematic review. *Neuroscience*, 342, 154–166. doi:10.1016/j.neuroscience.2015.09.001 [PubMed: 26343292]
- Green BL (1996). Trauma history questionnaire In Stamm BH (Ed.), *Measurement of stress, trauma, and adaptation* (pp. 366–369). Lutherville, MD: Sidran Press.
- Guintivano J, Arad M, Gould TD, Payne JL, & Kaminsky ZA (2014). Antenatal prediction of postpartum depression with blood DNA methylation biomarkers. *Molecular Psychiatry*, 19, 560–567. doi:10.1038/mp.2013.62 [PubMed: 23689534]
- Hompes T, Izzi B, Gellens E, Morreels M, Fieuws S, Pexsters A, . . . Claes S (2013). Investigating the influence of maternal cortisol and emotional state during pregnancy on the DNA methylation

- status of the glucocorticoid receptor gene (NR3C1) promoter region in cord blood. *Journal of Psychiatric Research*, 47, 880–891. doi:10.1016/j.jpsychires.2013.03.009 [PubMed: 23566423]
- Hooper LM, Stockton P, Krupnick JL, & Green BL (2011). Development, use, and psychometric properties of the trauma history questionnaire. *Journal of Loss and Trauma*, 16, 258–283. doi: 10.1080/15325024.2011.572035
- Kaminsky ZA, Assadzadeh A, Flanagan J, & Petronis A (2005). Single nucleotide extension technology for quantitative site-specific evaluation of metC/C in GC-rich regions. *Nucleic Acids Research*, 33, e95. doi:10.1093/nar/gni094 [PubMed: 15958788]
- Kimmel M, Kaminsky Z, & Payne JL (2013). Biomarker or pathophysiology? The role of DNA methylation in postpartum depression. *Epigenomics*, 5, 473–475. doi:10.2217/epi.13.51 [PubMed: 24059792]
- Kinser PA, Bourguignon C, Whaley D, Hauenstein E, & Taylor AG (2013). Feasibility, acceptability, and effects of gentle hatha yoga for women with major depression: Findings from a randomized controlled mixed-methods study. *Archives of Psychiatric Nursing*, 27, 137–147. doi:10.1016/j.apnu.2013.01.003 [PubMed: 23706890]
- Kinser PA, Goehler LE, & Taylor AG (2012). How might yoga help depression? A neurobiological perspective. *Explore (New York, NY)*, 8, 118–126. doi:10.1016/j.explore.2011.12.005 [PubMed: 22385566]
- Kinser PA, & Lyon DE (2014). A conceptual framework of stress vulnerability, depression, and health outcomes in women: Potential uses in research on complementary therapies for depression. *Brain and Behavior*, 4, 665–674. doi:10.1002/brb3.249 [PubMed: 25328843]
- Kinser PA, Elswick RK, & Kornstein S (2014). Potential long-term effects of a mind-body intervention for women with major depressive disorder: Sustained mental health improvements with a pilot yoga intervention. *Archives of Psychiatric Nursing*, 28, 377–383. doi:10.1016/j.apnu.2014.08.014 [PubMed: 25457687]
- Kinser P, & Masho S (2015). “Yoga was my saving grace”: The experience of women who practice prenatal yoga. *Journal of the American Psychiatric Nurses Association*, 21, 319–326. doi: 10.1177/1078390315610554 [PubMed: 26511433]
- Lapato DM, Moyer S, Olivares E, Amstadter AB, Kinser PA, Latendresse SJ, . . . York TP (2018). Prospective longitudinal study of the pregnancy DNA methylome: The US Pregnancy, Race, Environment, Genes (PREG) study. *BMJ Open*, 8, e019721. doi:10.1136/bmjopen-2017-019721
- Logsdon MC, & Hutti MH (2006). Readability: An important issue impacting healthcare for women with postpartum depression. *MCN: American Journal of Maternal/Child Nursing*, 31, 350–355.
- Lorig KR, & Holman HR (2003). Self-management education: History, definition, outcomes, and mechanisms. *Annals of Behavioral Medicine*, 26, 1–7. doi:10.1207/S15324796ABM2601_01 [PubMed: 12867348]
- McCain NL, & Smith JC (1994). Stress and coping in the context of psychoneuroimmunology: A holistic framework for nursing practice and research. *Archives of Psychiatric Nursing*, 8, 221–227. doi:10.1016/0883-9417(94)90063-9 [PubMed: 7979554]
- Menke A, & Binder EB (2014). Epigenetic alterations in depression and antidepressant treatment. *Dialogues in Clinical Neuroscience*, 16, 395–404. [PubMed: 25364288]
- Michels KB, Binder AM, Dedeurwaerder S, Epstein CB, Greally JM, Gut I, . . . Irizarry RA (2013). Recommendations for the design and analysis of epigenome-wide association studies. *Nature Methods*, 10, 949–955. doi:10.1038/nmeth.2632 [PubMed: 24076989]
- Moore CG, Carter RE, Nietert PJ, & Stewart PW (2011). Recommendations for planning pilot studies in clinical and translational research. *Clinical and Translational Science*, 4, 332–337. doi: 10.1111/j.1752-8062.2011.00347.x [PubMed: 22029804]
- Motl RW, Dishman RK, Trost SG, Saunders RP, Dowda M, Felton G, . . . Pate RR (2000). Factorial validity and invariance of questionnaires measuring social-cognitive determinants of physical activity among adolescent girls. *Preventive Medicine*, 31, 584–594. doi:10.1006/pmed.2000.0735 [PubMed: 11071840]
- Newham JJ, Westwood M, Aplin JD, & Wittkowski A (2012). State-trait anxiety inventory (STAI) scores during pregnancy following intervention with complementary therapies. *Journal of Affective Disorders*, 142, 22–30. doi:10.1016/j.jad.2012.04.027 [PubMed: 22959685]

- Sandelowski M (2000). Whatever happened to qualitative description? *Research in Nursing and Health*, 23, 334–340. doi:10.1002/1098-240X(200008)23:4<334::AID-NUR9>3.0.CO;2-G [PubMed: 10940958]
- Sherbourne CD, & Stewart AL (1991). The MOS social support survey. *Social Science & Medicine*, 32, 705–714. doi:10.1016/0277-9536(91)90150-B [PubMed: 2035047]
- Sidebottom AC, Harrison PA, Godecker A, & Kim H (2012). Validation of the Patient Health Questionnaire (PHQ)-9 for prenatal depression screening. *Archives of Women's Mental Health*, 15, 367–374. doi:10.1007/s00737-012-0295-x
- Tilton SR (2008). Review of the State-Trait Anxiety Inventory (STAI). *News Notes*, 48, 1–3.
- Treynor W, Gonzalez R, & Nolen-Hoeksema S (2003). Rumination reconsidered: A psychometric analysis. *Cognitive Therapy and Research*, 27, 247–259. doi:10.1023/A:1023910315561
- van Belle G (2002). *Statistical rules of thumb*. New York, NY: Wiley.
- Whaley DE (2004). Seeing isn't always believing: Self-perceptions and physical activity behaviors in adults. In Weiss MR (Ed.), *Developmental sport and exercise psychology: A lifespan perspective* (pp. 289–311). Morgantown, WV: Fitness Information Technology.
- Wright ML, Dozmorov MG, Wolen AR, Jackson-Cook C, Starkweather AR, Lyon DE, & York TP (2016). Establishing an analytic pipeline for genome-wide DNA methylation. *Clinical Epigenetics*, 8, 45. doi:10.1186/s13148-016-0212-7 [PubMed: 27127542]
- Yehuda R, Daskalakis NP, Desarnaud F, Makotkine I, Lehrner AL, Koch E, . . . Bierer LM (2013). Epigenetic biomarkers as predictors and correlates of symptom improvement following psychotherapy in combat veterans with PTSD. *Frontiers in Psychiatry*, 4, 118. doi:10.3389/fpsyt.2013.00118 [PubMed: 24098286]

Figure 1. Framework of factors involved in chronic depressive symptoms during pregnancy, aspects of "Mindful Moms" intervention, and outcome measures

[SES: socioeconomic status; PA: physical activity; DNAm: DNA methylation patterns; SM: self-management]

Figure 2. Data Collection Timepoints for Study in Relation to Archival Control Groups
MOS: MOS Social Support Survey; THQ: Trauma History Questionnaire; PHQ9: Patient Health Questionnaire; PSS: Perceived Stress Scale; STAI: State-Trait Anxiety Inventory; RRS: Ruminative Responses Scale; MFAS: Maternal-Fetal Attachment Scale; DNAm: DNA methylation; EPDS: Edinburgh Postnatal Depression Scale; PA: physical activity)