

# Association between mindful and practical eating skills and eating behaviors among racially diverse pregnant women in four selected clinical sites in the United States

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## Abstract

**Background:** Mindful eating is a promising strategy to address problematic eating behaviors; however, little is known about its applicability during pregnancy. No studies have examined the combined effects of mindful and practical eating skills on eating behaviors. **Aim:** We examined associations between mindful and practical eating skills and eating behaviors (nutritional intake and emotional eating) among pregnant women who received psychoeducation on healthy eating and pregnancies. **Methods:** Participants were racially-diverse pregnant women (14–42 years) from four clinical sites in Detroit, Michigan, and Nashville, Tennessee (N = 741). We conducted multiple linear regression to examine associations between mindful (hunger cues, satiety cues, mindful check-ins) and practical (food diary/journal, MyPlate method) eating skills and nutritional intake. We calculated residualized change scores to represent changes in the quality of nutritional intake from second to third trimester. We performed multiple logistic regression to examine associations between mindful and practical eating skills and emotional eating. **Results:** Women improved over time in eating behaviors (better nutrition, less emotional eating). Regular use of MyPlate was associated with better nutritional intake (unstandardized coefficient [B] = -0.61), but food diaries were not. We found a significant interaction in predicting emotional eating: For those regularly paying attention to hunger cues, some use of MyPlate (Adjusted Odds Ratio [AOR] = 0.39) and especially regular use of MyPlate (AOR = 0.13) reduced the likelihood of emotional eating during pregnancy. **Conclusion:** Enhancing both mindful and practical eating skills, such as paying attention to hunger cues, and using the MyPlate method, may facilitate pregnant women's ability to improve their eating behaviors.

## Keywords

Eating behaviors, emotional eating, mindful eating skills, nutritional intake, practical eating skills, pregnancy

## Introduction

Almost half of women in the United States enter pregnancy with overweight or obesity, and a similar proportion exceeds recommended guidelines for gestational weight gain (Dudenhausen et al., 2015; Deputy et al., 2015). Women with higher pre-pregnancy body mass indices (BMIs) ( $\geq 25 \text{ kg/m}^2$ ) are more likely to experience excessive gestational weight gain than those with healthy ( $\geq 18.5$  to  $< 25 \text{ kg/m}^2$ ) or lower ( $< 18.5 \text{ kg/m}^2$ ) pre-pregnancy BMIs (Nowak et al., 2019; Catov et al., 2022). Excessive weight gain during pregnancy confers numerous health risks for the mother and newborn, such as gestational diabetes (Santos et al., 2019; Zheng et al., 2019), pregnancy-induced hypertension (Santos et al., 2019;

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Zheng et al., 2019), and cesarean section delivery (Bouvier et al., 2019; Rogozińska et al., 2019). Among women with pre-pregnancy obesity, excess weight gain is associated with fetal macrosomia (Bouvier et al., 2019; Vats et al., 2021), preterm birth (Vats et al., 2021), childhood overweight/obesity, and metabolic syndrome (Woo et al., 2016; Voerman et al., 2019).

Eating behaviors are an important driver of maternal weight trajectories. Many pregnant women who struggle to adhere to recommended guidelines for gestational weight gain present with nutritional deficits (Fowles, 2002; Caut et al., 2020). Many also experience mood fluctuations (Li, 2020) that may influence their food selections (van Strien et al., 2013) and, in turn, their nutritional intake and weight status (Baños et al., 2014). Emotional eating is a response to negative emotions, such as anxiety or irritability, and may reflect general difficulties with emotion regulation (Brockmeyer et al., 2014). It is a dysregulated eating behavior typically characterized by the intake of a greater amount of calories than one would usually consume, or the intake of a greater proportion of calories from foods high in added sugar and/or fat (Ford et al., 2017). Among the general adult population, emotional eating is linked to weight fluctuation (Koenders and van Strien, 2011; Péneau et al., 2013; Keller and Siegrist, 2015), difficulties maintaining weight loss (Canetti et al., 2009; López-Guimerà et al., 2014), binge eating (defined by eating an objectively large amount of food, and loss of control) (Lehr et al., 2015), and depressed mood (van Strien et al., 2016). Conversely, alleviating or reducing emotional eating is associated with weight loss maintenance among adults (Braden et al., 2016), but has not yet been examined in relation to healthy gestational weight gain and postpartum weight loss.

Mindful eating is the nonjudgmental awareness of physical and emotional sensations while eating or in a food-related environment. (Kristeller and Wolever, 2011). The purpose of mindful eating is not to lose weight, although it could be employed as a weight maintenance method (Framson et al., 2009). It has been utilized to treat behaviors associated with overweight and obesity, such as problematic eating behaviors (e.g., binge eating) and food cravings, and has been shown to improve attitudes and behaviors toward eating (Alberts et al., 2010; Dalen et al., 2010; Alberts et al., 2012). Emerging evidence suggests that mindful eating may influence metabolic health in non-pregnant individuals (Daubenmier et al., 2016; Warren et al., 2017), but its effects in the context of pregnancy are less well understood. Findings from a recent prospective observational study of 46 pregnant women with obesity on the determinants of gestational weight gain suggest mindful eating as a potential tool to improve metabolic health outcomes; however, this study had limited power to detect significant effects (Lindsay et al., 2021).

Mindful eating requires cultivating skills such as paying attention to the body's internal cues (i.e., hunger and satiety) and using mindful check-ins at meal or snack

times to avoid overconsumption of food. Learning to pay attention to internal cues can also help individuals recognize, but not necessarily respond to, negative emotions such as anxiety or irritability (Framson et al., 2009). Awareness of emotions, as well as hunger and satiety cues, are essential to achieve mindful eating (Monroe, 2015).

Mindful eating skills are distinct from the practical eating skills or external wisdom often taught for weight management, such as meal planning, record keeping, and portion control (Framson et al., 2009). Practical eating skills address how to understand and make 'wiser' choices based on personal relevance to the enormous amount of nutritional information available (Kristeller and Epel, 2014). Interventions that incorporate mindfulness in addition to practical eating skills may yield improved results with respect to individuals' ability to self-regulate their eating. However, no studies have reported their combined effects of these approaches on eating behaviors, particularly during pregnancy.

This study aimed to examine the associations between mindful and practical eating skills and eating behaviors among pregnant women. We hypothesized that practicing both skills would be associated with improved nutritional intake and decreased emotional eating among pregnant women from second to third trimester.

## Methods

### Study design and population

We conducted a secondary data analysis from *Expect With Me*, a prospective cohort study among pregnant women, wherein the investigators utilized a group prenatal care model aimed at improving maternal health and birth outcomes (Cunningham et al., 2017). This study was conducted at four clinical sites in Detroit, Michigan and Nashville, Tennessee, between 2014 and 2017. Purposive sampling was conducted to recruit participants. Women attending prenatal care at these four sites were referred by healthcare providers or research staff to participate in the study. Eligibility criteria were: <24 weeks gestation upon enrollment, lack of serious medical problem requiring only individualized care, ability to speak English or Spanish, and voluntary participation. Women were diverse in age, ethnicity, and socio-economic status.

We recruited women during their second trimester of pregnancy (< 24 weeks' gestation) and followed them until one year postpartum. After an initial individual assessment, all prenatal care visits were scheduled to occur within a group setting unless a severe medical issue required privacy or cervical examinations in late pregnancy. If a participant missed a group session, she had the option of rescheduling that appointment as an individual care visit. We considered women who attended at least one group prenatal care visit as having received group prenatal care. Before data collection, staff at each clinical site explained

the study to eligible women and obtained written informed consent. Participants completed online surveys at multiple time points: second trimester, third trimester, at childbirth, and at six and twelve months postpartum. They were paid \$20 as an incentive for each survey timepoint. We received ethical clearance from the Institutional Review Boards at Yale, Vanderbilt, and Wayne State Universities.

In the *Expect With Me* model, a credentialed prenatal care provider (e.g., obstetrician, midwife) and co-facilitator (e.g., nurse, medical assistant) led a small group prenatal care session consisting of 8 to 12 pregnant women of similar gestational age. Each group session (a total of 10 sessions) ran for 120 min and followed a structured curriculum incorporating the American Congress of Obstetrics and Gynecology (ACOG) standard prenatal care content (AAP Committee on Fetus and Newborn and ACOG Committee on Obstetric Practice, 2017). The sessions comprised pregnancy health assessments and skill-building activities with education on nutrition, physical activity, mental health, sexual health, newborn care, self-care activities, and building healthy relationships through partner or peer support in prenatal care. A unique feature of *Expect With Me* relative to other group prenatal care models is the incorporation of content to promote mindful and practical eating skills, which fall under the nutrition theme. These topics were primarily addressed during the first two group sessions and reinforced on an ongoing basis. The mindfulness components were adapted from the Mindfulness-Based Eating Awareness Training (MB-EAT) (Kristeller and Wolever, 2011), Maternal Adiposity, Metabolism and Stress (MAMAS) Study (Coleman-Phox et al., 2013), and Mindful Moms Training (Vieten et al., 2018).

Analyses for this paper utilized data collected during the second and third trimesters of pregnancy. We limited the cohort to participants with complete data for the exposure and outcome variables of interest, resulting in an analytic sample of 741. Compared to pregnant women included in this analytic sample, those excluded were more likely to be Black and younger ( $p < 0.05$ ). There were no other socio-demographic or clinical differences.

## Measures

### Outcome variables

**Nutritional intake.** We used the 8-item Starting the Conversation (STC) food frequency instrument to measure pregnant women's nutritional intake. Non-dietitians use this simplified screening scale in clinical practice for nutritional assessment and counseling (Paxton et al., 2011). The scale identifies dietary patterns and was derived from a validated 54-item instrument (Jilcott et al., 2007). Example items include, "During the past few months, how many times a week did you eat regular snack chips or crackers (not low fat)?" and "How many servings of fruit did you eat each day?" The response options for the survey items are

organized into three categories: most healthful dietary practices (scored 0), less healthful practices (scored 1), and the least healthful practices (scored 2). We calculated the summary score (range 0–16) by adding item scores, with lower summary scores reflecting a more nutritious diet (i.e., greater fruit and vegetable intake) and higher scores reflecting a less nutritious diet (greater sugar and fat intake). The scale is robust across various patient characteristics, sensitive to treatment, stable over time, and publicly available in English and Spanish (Paxton et al., 2011). The STC showed acceptable reliability: Cronbach's alpha in this study was 0.72.

**Emotional eating.** We used a single-item question to measure emotional eating by asking women, "How often do you eat to forget your worries or to cheer self-up when you are in a bad mood?" with response options ranging from 1 (never) to 5 (always). We categorized women who answered 'sometimes, often, always' as having engaged in emotional eating, whereas those who answered 'rarely or never' were categorized as not having engaged in emotional eating.

### Exposure variables

**Mindful eating skills.** We assessed three mindful eating skills over the previous month: awareness of hunger cues, awareness of satiety cues, and mindful check-ins.

We assessed hunger cues by the following question: how often did you "pay attention to physical hunger or fullness to help eat the right amount of food?" We assessed satiety cues by the following question: how often did you "stop eating sooner when food stopped tasting good?" We assessed mindful check-ins by the following question: how often did you "use mindful check-ins at meal/snack times?" Responses ranged from 1 (not at all) to 6 (more than once per day) and all questions referred to women's practice over the previous month. Mindful check-ins are using 'mini-meditations' to think about food. This can be done by taking a few deep breaths before eating and becoming aware of your body and mind (Kristeller and Wolever, 2011).

**Practical eating skills.** We assessed two practical eating skills: food diary/journal and the MyPlate method (i.e., an easy-to-follow food guide to help individuals plan nutritious and balanced meals). Women were asked, "over the last month, how often did you keep a food diary/journal," and "how often did you use the MyPlate method to help make food choices or notice portion sizes." Responses ranged from 1 (not at all) to 6 (more than once per day).

Both of these exposure variables were recategorized as never (not at all), sometimes (about once a week or less), and regularly (several times a week to usually once a day or more than once a day). Questions were adapted from the Mindfulness-Based Eating Awareness Training (MB-EAT) (Kristeller and Wolever, 2011) and Mindful Moms Training (Vieten et al., 2018).

**Covariates/confounders:** *Participant characteristics, group session attendance, and study site.* We included the following variables as covariates in all analyses: self-reported socio-demographic characteristics, including age, race, education, employment, relationship status, and insurance status.

We treated age as a continuous variable. Race was treated as a categorical variable, and grouped into White, Black, and Other. We categorized education as less than high school, high school graduate/General Educational Development (GED), and some college or higher. We dichotomized employment as either employed or unemployed. We classified relationship status as non-committed (i.e., single, never married/separated/divorced) or committed (i.e., married or not married, but living with a partner). We categorized insurance status into private, public/Medicaid, and no insurance.

We calculated BMI based on self-reported pre-pregnancy weight and height before pregnancy. We also controlled for group prenatal care visit attendance (attended session 1 and/or 2 where mindful and practical eating skills building content was delivered vs. did not attend either) and study site to account for any potential confounding bias.

### Data analysis

We used descriptive statistics to summarize participant characteristics at second trimester. Subsequently, we employed paired t-tests and chi-square tests to compare outcome data between the second and third trimesters of pregnancy. Additionally, we conducted two separate regression analyses for each outcome. First, we performed multiple linear regression to examine the associations between mindful and practical eating skills and nutritional intake. We calculated residualized change scores to represent changes in the quality of nutritional intake from second to third trimester. We computed unstandardized residuals by regressing third-trimester nutritional intake on its baseline (second-trimester) data. Positive residualized scores indicated worsening nutritional intake from second to third trimester. Second, we performed multiple logistic regression to examine the associations between mindful and practical eating skills and emotional eating. All models controlled second-trimester outcome data, participant characteristics, group session attendance, and study site. We also tested for interaction effects between mindful and practical eating skills with the outcomes. We conducted all statistical analyses using Stata 17.0 (StataCorp, College Station, TX, USA) and considered a p-value of less than 0.05 to be statistically significant.

## Results

### Participant characteristics

Table 1 shows the characteristics of the pregnant women. At second trimester, they had a mean (standard deviation

**Table 1.** Characteristics of pregnant women at second trimester (n = 741).

Characteristics	n	%
<b>Demographics</b>		
Age, mean (SD); range: 14–42 years	25.0	(5.4)
Race		
White	178	24.0
Black	470	63.4
Other <sup>1</sup>	93	12.6
Education		
Less than high school	114	15.4
High school graduate/GED	305	41.2
Some College or higher education	322	43.5
Employment		
Employed	385	52.0
Unemployed	356	48.0
Relationship status		
Single, never married/separated/divorced	461	62.2
Married/ Not married, but living with partner	280	37.8
Insurance status		
Private	206	27.8
Public/Medicaid	506	68.3
No insurance	29	3.9
BMI group		
Underweight	29	3.9
Healthy	291	39.3
Overweight	164	22.1
Obese	257	34.7
<b>Mindful eating skills</b>		
Hunger cues		
Never	140	18.9
Sometimes	130	17.5
Regularly	471	63.6
Satiety cues		
Never	237	32.0
Sometimes	226	30.5
Regularly	278	37.5
Use mindful 'check-ins' at meal/snack times		
Never	517	70.0
Sometimes	124	16.7
Regularly	100	13.5
<b>Practical eating skills</b>		
Keep a food diary/journal		
Never	621	83.8
Sometimes	73	9.9
Regularly	47	6.3
Use MyPlate method		
Never	485	65.5
Sometimes	129	17.4
Regularly	127	17.1

<sup>1</sup> Other includes Asian, Native American, multiple races, among others; GED — General Educational Development; BMI — Body Mass Index; Never — not at all; Sometimes — about once a week or less; Regularly — several times a week to usually once a day or more than once a day.

[SD]) age of 25.0 (5.4) years. Of 741 women, 470 (63.4%) self-identified as Black, 178 (24.0%) as White, and 93 (12.6%) as other races. Nearly half (48.0%) were unemployed and only 15.4% had less than high school education. Most (62.2%) were in non-committed relationships

and covered by public/Medicaid insurance (68.3%). One-third were obese (34.7%) and nearly a quarter (22.1%) were overweight. At third trimester, 63.6% and 37.5% of women reported regularly paying attention to hunger and satiety cues, respectively. Only 13.5% regularly used mindful check-ins at meal/snack times, 6.3% regularly kept a food diary/journal and 17.1% regularly used the MyPlate method. About three-quarters (74.0%) of the participants attended sessions 1 and/or 2.

Table 2 compares the outcome variables at second and third trimester of pregnancy. Women showed improvement in nutritional intake (8.19 vs 7.85,  $p$ -value = 0.001) and reductions in emotional eating (170 vs. 150,  $p$ -value < 0.001) from second to third trimester.

### Association of mindful and practical eating skills with changes in eating behaviors

Table 3 shows regression models predicting changes in nutritional intake and emotional eating among pregnant women. After controlling for covariates and second-trimester outcome data, regular use of the MyPlate method was associated with better nutritional intake (unstandardized coefficient [B] = -0.61,  $p$ -value = 0.023). ‘Regularly’ paying attention to hunger cues (Adjusted Odds Ratio [AOR] = 2.66,  $p$ -value < 0.001), ‘sometimes’ paying attention to satiety cues (AOR = 1.24,  $p$ -value = 0.015), ‘regularly’ using mindful check-ins at meal/snack times (AOR = 1.36,  $p$ -value = 0.040), and using MyPlate ‘sometimes’ (AOR = 2.25,  $p$ -value < 0.001) or ‘regularly’ (AOR = 8.09,  $p$ -value < 0.001) were associated with higher odds of emotional eating. However, there was a significant interaction between hunger cues and using the MyPlate method (hunger cues (regularly) x MyPlate method (sometimes): AOR = 0.39,  $p$ -value < 0.001; hunger cues (regularly) x MyPlate method (regularly): AOR = 0.13,  $p$ -value < 0.001) suggesting that both may be necessary to decrease the odds of emotional eating during pregnancy.

## Discussion

On average, women attending *Expect With Me* group prenatal care showed improvement in nutritional intake and reductions in emotional eating from second to third

**Table 2.** Comparison of outcome variables at second and third trimester of pregnancy.

Measures	Second trimester	Third trimester	p-value
<b>Outcome variables</b>			
Nutritional intake, mean (SD)	8.19 (2.71)	7.85 (2.67)	0.001
Emotional eating, n (%)	170 (25.1)	150 (22.1)	<0.001

Note: Higher scores in nutritional intake reflect a less nutritious diet.

trimester. Regular use of the MyPlate method was associated with better nutritional intake. Paying attention to hunger and satiety cues, regular mindful check-ins at meal/snack times, and use of MyPlate were independently associated with higher odds of emotional eating. However, we observed a significant interaction between hunger cues and the MyPlate method, suggesting that both may be necessary to reduce the likelihood of emotional eating among pregnant women.

Pregnant women who regularly used the MyPlate method showed better nutritional intake. This is the first study that shows the association between the frequency of use of the MyPlate method and nutritional intake. Previous studies have mainly focused on the association between familiarity and self-perceived diet quality among the general population (Tagtow and Raghavan, 2017; Jahns et al., 2018). Our findings are also first among pregnant women, who are at risk for nutritional deficiencies (Fowles, 2002; Caut et al., 2020). As a dietary guidance icon, MyPlate may have prompted them to make healthy food choices and improve their nutritional intake.

We found a significant interaction between paying attention to hunger cues (mindful eating skill) and using the MyPlate method (practical eating skill) in reducing the likelihood of emotional eating during pregnancy. Independently, greater application of each skill was associated with increased emotional eating, but combining them may have salutary effects. For instance, paying attention to hunger cues regularly and using the MyPlate method regularly/sometimes significantly decreased odds of emotional eating. This adds value to cultivating both internal and external ‘wisdom’ in regard to creating a new and sustainable relationship between food and eating (Kristeller and Jordan, 2018). This finding is new and warrants further investigation into how these variables interplay with emotional eating.

Our finding that mindful eating skills, such as paying attention to satiety cues and regular mindful check-ins at meal/snack times, increased the risk for emotional eating contrasts with prior studies demonstrating the positive influence of mindfulness on eating behaviors among the general population (Warren et al., 2017). For example, training in mindful eating may teach individuals to manage urges when experiencing negative mood (Sagui-Henson et al., 2021). However, most studies on mindful eating interventions targeted behaviors such as food cravings (Sagui-Henson et al., 2021) and binge eating episodes (Godfrey et al., 2015). None focused specifically on emotional eating. Additional research is needed to examine the effectiveness of mindful eating interventions on emotional eating.

Kristeller and colleagues (2014) highlight the importance of teaching individuals to cultivate greater awareness of emotional states and external triggers (e.g., stress) to interrupt dysfunctional emotional eating cycles. Our findings further extend this principle and suggest the integration of both mindful and practical eating skills in improving

**Table 3.** Multivariate linear and logistic regression models predicting changes in nutritional intake and emotional eating among pregnant women.

Variables	Nutritional intake (n = 713)		Emotional eating (n = 678)	
	B (95% CI)	p-value	AOR (95% CI)	p-value
Second-trimester nutritional intake	-0.08 (-0.15, -0.01)	0.029		
Second-trimester emotional eating			4.71 (2.88, 7.68)	<0.001
Mindful eating skills				
Hunger cues (vs. Never)				
Sometimes	0.58 (-0.05, 1.20)	0.070	2.07 (1.21, 3.53)	0.008
Regularly	0.23 (-0.27, 0.73)	0.369	2.66 (1.65, 4.29)	<0.001
Satiety cues (vs. Never)				
Sometimes	0.10 (-0.36, 0.56)	0.667	1.24 (1.04, 1.46)	0.015
Regularly	0.05 (-0.39, 0.49)	0.830	1.21 (0.70, 2.10)	0.492
Use mindful 'check-ins' at meal/snack times (vs. Never)				
Sometimes	-0.18 (-0.69, 0.33)	0.487	0.86 (0.58, 1.29)	0.471
Regularly	-0.12 (-0.74, 0.50)	0.697	1.36 (1.01, 1.82)	0.040
Practical eating skills				
Keep a food diary/journal (vs. Never)				
Sometimes	-0.51 (-1.13, 0.11)	0.108	1.52 (0.89, 2.60)	0.122
Regularly	-0.31 (-1.05, 0.43)	0.405	0.60 (0.30, 1.20)	0.148
Use MyPlate method (vs. Never)				
Sometimes	-0.13 (-0.60, 0.33)	0.581	2.25 (1.90, 2.66)	<0.001
Regularly	-0.61 (-1.14, -0.09)	0.023	8.09 (2.90, 22.55)	<0.001
Age	-0.03 (-0.06, 0.01)	0.096	1.00 (0.94, 1.07)	0.924
Race (vs. Black)				
White	-0.33 (-0.80, 0.14)	0.168	0.64 (0.38, 1.09)	0.102
Other <sup>1</sup>	-0.78 (-1.30, -0.27)	0.003	1.00 (0.65, 1.56)	0.986
Education (vs. Some College or higher education)				
Less than high school	0.02 (-0.54, 0.58)	0.941	2.48 (1.10, 5.58)	0.028
High school graduate/GED	0.17 (-0.24, 0.58)	0.416	0.99 (0.67, 1.46)	0.953
Employment (vs. Employed)				
Unemployed	-0.09 (-0.46, 0.28)	0.649	1.11 (0.65, 1.89)	0.712
Relationship status (vs. Single, never married/separated/divorced)				
Married/ Not married, but living with partner	-0.40 (-0.80, 0.00)	0.052	0.52 (0.29, 0.94)	0.032
Insurance status (vs. Public/Medicaid)				
Private	-0.15 (-0.59, 0.29)	0.497	1.17 (0.97, 1.41)	0.105
No insurance	1.22 (0.48, 1.95)	0.001	1.49 (0.44, 5.07)	0.522
BMI group (vs. Other)				
Overweight/Obese	0.17 (-0.18, 0.52)	0.347	1.59 (0.88, 2.87)	0.125
Group session attendance (vs. No)				
Yes	0.34 (-0.06, 0.74)	0.100	1.38 (0.61, 3.13)	0.439
Hunger cues (regularly) x use MyPlate method (sometimes)			0.39 (0.33, 0.47)	<0.001
Hunger cues (regularly) x use MyPlate method (regularly)			0.13 (0.05, 0.31)	<0.001
R <sup>2</sup> or Pseudo R <sup>2</sup>	7.7***			15.5***

<sup>1</sup>Other includes Asian, Native American, multiple races, among others. B — unstandardized coefficients; AOR — adjusted odds ratio; CI — confidence interval. Statistical significance indicated by \* p < 0.05; \*\* p < 0.01; \*\*\* p < 0.001.

emotional functioning and empowering at-risk individuals (e.g., pregnant women) to make positive choices about food, eating, and coping, without focusing on weight outcomes. This may be one possible mechanism to reduce problematic emotion-related eating.

The improvements in nutritional intake and emotional eating observed from second to third trimester among pregnant women who participated in the *Expect With Me* could be attributed to the course content, guided facilitation by healthcare providers, and dynamic learning and sharing of

experiences among group participants. A goal of group prenatal care is to empower pregnant women to own and manage their health. Facilitators make sure to emphasize the positive. They acknowledge problems and difficulties but focus on overcoming challenges pregnant women face. Compared to standard individual care, group prenatal care is associated with healthier maternal weight trajectories (Magriples et al., 2015), among other improved maternal and child health outcomes (Ickovics et al., 2007, 2016; Byerley and Haas, 2017). This is the first study to

examine eating behaviors among group prenatal care participants.

This study has several limitations. The measures used relied upon self-reports and are therefore subject to socially desirable responses. We assessed emotional eating using a single-item question, which may have limited variability in women's responses. We suggest using a validated emotional eating scale in future studies. The STC food frequency instrument used to assess nutritional intake did not measure the amount and nutritional composition of food intake. We also did not collect data on prior eating disorder history and other socio-cultural factors that may affect eating behaviors. The potential impact on social relationships, particularly with members of the same household, has been identified as a significant barrier to sustaining dietary change, highlighting the influence of norms on eating behavior (Bianchi et al., 2016). Partners are encouraged to attend group prenatal care sessions, but data was not available to assess the extent to which partners engaged in or supported participants' healthy eating behaviors. Pregnant women self-selected to participate in group rather than traditional prenatal care, thus the sample may not represent all women at risk for unhealthy eating behaviors. Finally, we did not have a control group, limiting our analyses to only those who attended the group prenatal care sessions.

Despite these limitations, this study has several strengths. First, we assess the changes in outcomes at two time points: second and third trimesters of pregnancy. Thus, it provides evidence of change in nutritional intake and emotional eating during the prenatal period. This is the first study to examine the independent associations of mindful and practical eating skills on the eating behaviors of pregnant women. It is also the first to investigate the interaction effects between these two types of skills on eating behaviors, providing evidence on the importance of incorporating both to achieve healthier outcomes. Furthermore, we used a large, racially diverse sample of pregnant women, measured and controlled for covariates/confounders, and used validated measures of nutritional intake, all of which strengthen the internal validity of our study findings.

## Conclusions

Pregnancy represents a window of opportunity for behavior change that can improve metabolic trajectories. Combining mindful and practical eating skills has the potential to address problematic eating behaviors (i.e., emotional eating) and the challenges many pregnant women face with controlling their food intake. Specifically, paying attention to both internal cues of hunger and the MyPlate method may empower pregnant women to improve food choices, and bridge the gap between their knowledge and behavior. This may, in turn, result in a positive shift with food habits including the quantity and quality of food consumed. Prenatal lifestyle interventions should consider

cultivating both mindful and practical eating skills to reduce adverse maternal and child health outcomes associated with excessive gestational weight gain.

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## Author contributions

JL, JL, and SC were involved in conceptualization, methodology, validation, conducting research, fund acquisition, and overall supervision. RRC, EE, and RR were involved in conceptualization, methodology, and validation. RRC conducted data analysis, data curation, visualization, and original draft writing. RRC, EE, RR, JL, JL, and SC were involved in the review and editing of the draft. All authors have read and agreed to the published version of the manuscript.

## Availability of data and materials

Data will be available on request from the corresponding author.

## Consent for publication

All authors have given their consent for publication.

## Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Ethics approval

This study was approved by Institutional Review Boards at Yale, Vanderbilt, and Wayne State Universities (HIC #1304011772).

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