How Do Expectations Around Gestational Weight Gain Influence Disordered Eating?

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# **Abstract**

**Background**: Expectations around gestational weight gain (GWG) during pregnancy have not been widely explored or considered in the literature. Mental health consequences like disordered eating, are common during pregnancy, but have not been considered in the creation of the National Academy of Medicine (NAM) Guidelines around GWG. The aim of this study was to examine the relationship between GWG and disordered eating during the 3rd trimester of pregnancy and whether expectations compared to a pregnant individual's actual GWG (misalignment) act as an effect modifier of that relationship.

**Methods:** 86 individuals from the PRESS (Pregnancy Related Eating, Sleeping, and Stress) cohort completed questionnaires throughout their pregnancy in relation to their expectations around GWG and completed the EDE-QS during their third trimester of pregnancy. Individuals were grouped into misalignment categories based on a 5lb difference between expectations and actual GWG.

**Results**: After adjusting for pre-pregnancy BMI, the association between GWG and disordered eating during trimester 3 was positively associated, where a 10 lb. increase in GWG was associated with a 32% increase in disordered eating at trimester 3 (p = 0.006). Although expectations relative to actual GWG was not found to significantly modify the relationship between GWG and disordered eating (p = 0.46), individuals who had expectations aligned with their actual GWG (aligned GWG) had on average a 10% increase in disordered eating compared to participants who overestimated their GWG, and on average a 35% increase in disordered eating compared to participants who underestimated their true GWG.

**Conclusion:** There is a clear relationship between GWG and disordered eating at trimester 3. There may be unintended consequences of NAM guidelines around GWG, specifically in setting expectations, and more research needs to be conducted to understand how guidelines like these are impacting pregnant individuals not only physically but mentally.

# **Introduction**

Pregnancy is a very critical period of development for a child and brings about many physiological and mental changes for the pregnant individual. In fact, one physical and rapid change that occurs for the pregnant individual comes from gestational weight gain. The Institute of Medicine (IOM), more recently known as the National Academy of Medicine (NAM), has established recommended ranges of pregnancy weight gain with the goal of optimizing health outcomes for a pregnant person and their child. The most recent guidelines published in 2009 considered outcomes including cesarean delivery, postpartum weight retention, preterm birth, small or large-for-gestational age at birth, childhood obesity, among other physical health outcomes for both the parent and child. It included four recommended ranges of pregnancy weight gain that differed according to pre-pregnancy BMI, as follows: BMI <18.5 kg/m2 (“underweight”): 28-40 lbs., BMI 18.5-24.9 kg/m2 (“normal weight”): 25-30 lbs., BMI 25.0-29.9 kg/m2 (“overweight”): 15-25 lbs., BMI >30.0 kg/m2 (“obese”): 11-20 lbs.1. The previous guidelines, which were released in 1990, included four different sets of recommendations also based on pre-pregnancy BMI, BMI <18.5 kg/m2 (“underweight”): 28-40 lbs., BMI 18.5-24.9 kg/m2 (“normal weight”): 25-30 lbs., BMI 25.0 -29.9 kg/m2 (“overweight”): 15-25 lbs., and BMI >30.0 kg/m2 (“obese”): at least 15 lbs.1. These replaced the original IOM guidelines from 1970 which recommended a weight gain range of 20-25 lb. for all pregnant people, irrespective of pre-pregnancy BMI. Overall, the differences in recommended weight gain ranges over time have altered in the number of categories, ranges of weight gain given, and the overlap between the various pre-pregnancy BMI categories.

The majority of pregnant people are not gaining weight within their NAM recommended weight range 2,3. A pregnant person’s mental health is one possible explanation. Past studies have found that depression and anxiety are associated with lower weight gain during pregnancy 4, where one study saw that pregnant people with persistent depressive symptoms during pregnancy presented a 0.1 kg/week lower rate of GWG throughout pregnancy and a 140% increased risk of insufficient weight gain 5. A recent review on the impact of psychosocial factors and their relationship to gestational weight gain found that gestational weight gain can be influenced by intimate partner violence, lack of social support and recognition, financial distress, household food insecurity, chronic stress and depression related to pregnancy, low self-esteem, and eating pathologies 6. While mental health outcomes, like DSM V diagnosed eating disorders (ED), have been shown to lead to negative health outcomes for both the parent and child 7,8, the prevalence of having a diagnosed ED in pregnancy is extremely low 9. However, disordered eating, which is a term used to describe a range of irregular eating behaviors that may or may not warrant a diagnosis of a specific eating disorder 10, is more common. One small study, saw that about 52% of mothers felt preoccupied with thoughts of food or weight, 44% experienced binge eating, and 30% felt out of control of their eating and weight 11. Another study found that 52% of pregnant people were dissatisfied with their bodies 12. Additionally, 27.8% of pregnant people who completed an eating disorder questionnaire retrospectively had a typical clinical or elevated subclinical score on one or more of the eating disorder subscales, where body dissatisfaction was most prevalent 13. Although the prevalence of a full syndrome eating disorder is less common during pregnancy, disordered eating behaviors and tendencies seem to exist within the context of pregnancy.

Both eating disorders (ED) and disordered eating (DE) are implicated in negative health outcomes for pregnant individuals and their children. A recent systematic review found that 1 out of 20 pregnant individuals are at risk for an ED during pregnancy, where 40% were concerned about their weight during pregnancy 14. Among individuals who did not have a diagnosed eating disorder, worry over gestational weight gain was associated with greater GWG, greater child birth weight, greater likelihood for LGA infants and smaller likelihood for SGA infants 15. Because the type of eating disorder that an individual may have affects the outcomes associated with the disorder, many studies have found differing negative health consequences. Children born to individuals with bulimia nervosa (BN) and eating disorders not otherwise specified (EDNOS) postpartum were smaller, both in terms of weight for length and weight for age, and are more highly sensitive to their children’s shape 16, where studies looking at individuals with anorexia nervosa (AN) found their children had small birth length and individuals with binge eating disorder (BED) had an increased risk of LGA infants 17. When examining specific eating disorder pathologies, pregnant people with frequent loss of control eating (LOC) had higher GWG compared to pregnant people with no LOC eating 18. In fact, pregnant people who had frequent LOC eating had a 3-fold increased odds of gaining more weight than the NAM guidelines 18**.** Other eating disorder pathologies, like body image, self-efficacy, attitudes toward weight gain, binge eating and dietary restraint have been shown to be predictors of excessive GWG 19–21. Disordered eating scores have also been shown to increase with an increase in BMI, and as GWG compared to NAM guidelines move from inadequate to excessive GWG 22,23. Higher eating disorder tendencies during pregnancy are also associated with an increase in disordered eating postpartum 24. Body dissatisfaction, a common eating disorder pathology that occurs postpartum, was also found to be correlated with depression and self-esteem issues 25, which has been shown to lead to issues with breastfeeding 26.

Another reason why pregnant people may not be meeting NAM guidelines may be due to their own expectations on GWG differing from guidelines, a factor not considered when guidelines were developed. One large study conducted among preconception and pregnant people found that inaccuracies in gestational weight gain knowledge and beliefs are common. Specifically, 12.4% of pregnant and 40.2% of preconception individuals in this study reported expecting to gain less than recommendations, while 43.1% of pregnant and 25.8% of preconception pregnant people expected to gain more than the recommendations, which highlights the fact that pregnant people are not aware or do not agree with NAM guidelines 27. Another recent study found that pregnant people who were expecting to gain excessively, in relation to NAM guidelines, were 52% more likely to gain excessive gestational weight, compared to 38% of people who expected to gain within IOM guidelines 28. Furthermore, when pregnant people were asked about their GWG goals and self-reported provider weight gain goals, the proportion of women whose weight gain was within IOM guidelines was not meaningfully different according to whether the goal was within or outside the IOM recommendations, and their actual weight gain was on average 11.5 lbs. higher than goals 29. Pregnant individuals continuously do not gain within NAM weight recommendations, no matter their pre-pregnancy BMI and setting goals to gain within guidelines have not been an effective way to help pregnant individuals gain within guidelines. Few studies to date have examined the alignment between a pregnant person’s expected gestational weight gain, and the actual amount of weight they gain, and whether a misalignment between any of these 2 constructs may uniquely relate to mental health outcomes. A recent study looked at the pathway to postpartum disordered eating, and showed that body dissatisfaction, along with dysfunctional beliefs about motherhood, and negative self-compassion lead to negative affect, which in turn leads to disordered eating 30. Beliefs contradicting NAM guidelines on gestational weight gain could be providing a similar effect on disordered eating during pregnancy and actual gestational weight gain.

The NAM guidelines on GWG have remained the key resource guiding pregnant people on the “proper” amount of weight to gain for a healthy child, however despite public health efforts, most pregnant individuals are not following these guidelines. While the literature shows that there is a relationship between disordered eating and gestational weight gain, many studies examine the unidirectional relationship where eating disorders lead to GWG outside NAM guidelines and focus on comparing a pregnant person's weight gain to the NAM guidelines rather than personal expectations. The changes to recommendations over time have not considered the mental health implications of these recommendations on a pregnant person nor a pregnant individual's expectations on weight gain during pregnancy. Neglecting to gather this information could lead to outcomes like disordered eating and could be the reason as to why pregnant individuals continuously do not adhere to guidelines. Therefore, we propose to examine how a pregnant person’s expected gestational weight gain will impact the relationship between their actual GWG and disordered eating outcomes. We hypothesize that a pregnant person who gains more than they expected will experience increased disordered eating at the end of their pregnancy. This information will be extremely valuable to the public health community as disordered eating has many negative health consequences that not only will impact the pregnant person but also their child and may be playing a large role in discrepancies between guidelines and actual weight gained during pregnancy.

# **Methods**

### **Population**

The data for this study came from the PRESS cohort (Pregnancy Related Eating, Sleeping, and Stress). PRESS participants were recruited through the Michigan Institute for Clinical and Health Research (MICHR) as well as email recruitment in partnership with Michigan Medicine Obstetrics and Gynecological Department. Participants who were recruited through MICHR could access the screener and consent survey with the public link listed on the MICHR study website. Between June 30, 2022, and October 1st, 2022, the study team received monthly data on all OB patients receiving care at Michigan Medicine. The research staff emailed the individuals from the list inviting them to participate in the study. If they elected to participate, they were taken to a secure online survey platform, REDCap, which started with an eligibility screening, followed by a consent form. To be eligible for the study, participants had to be over 18 years of age, pregnant and between 1-30 weeks’ gestation, as well as be a Michigan Medicine patient. In the end, almost all participants were recruited through the Michigan Medicine email method.

Due to recruitment capturing individuals between 1-30 weeks’ gestation, participants entered the study at various time points. Participants were categorized into trimesters based on their responses to “what week of your pregnancy are you currently in?” as well as medical chart verification. Individuals who completed the first survey in their first trimester (1-13 weeks gestation) were eligible to receive trimester 2 (weeks 14-28 gestation) and trimester 3 (weeks 29-42+ gestation). Additionally, individuals who completed their first survey in trimester 2 were only eligible for the trimester 3 survey, and those who completed their first survey in their third trimester were not eligible for any subsequent surveys. Trimester 2 and 3 surveys contained the same questionnaires as the first survey except did not ask about demographic information nor GWG expectation. The trimester 3 survey included an additional question; “What is your most recent weight in pounds (lbs.)?” (Figure 1).

### **Participant Measures**

Demographics and Other Covariates

Demographic data collected from the initial survey including self-reported information on race/ethnicity, maternal age, parity, household income, maternal education, number in household, smoking status, second-hand smoking status, relationship status, eating disorder history, planned pregnancy status, physical activity, pre-pregnancy weight, marital status, stress, nausea and vomiting, and gestational weight gain expectations. Maternal age was calculated using consent date and date of birth, and parity was also collected from electronic health records (EHR). Stress was measured using the perceived stress scale (PSS) and nausea and vomiting was measured using the PUQE-24 questionnaire. Higher scores indicated higher stress levels or more nausea and vomiting, respectively. Both were collected during all three time point surveys. Other information collected from the PRESS cohort that were not included for this analysis were meal and sleep timing and dietary quality.

The following demographic categories were condensed due to lower than 10 participants in the categories: maternal education, income, maternal BMI, marital status, and race/ethnicity. Information on various racial categories, including Black or African American, Asian or Asian American, Hispanic, Latinx, or Spanish Origin, Middle Eastern or North African, or Other were collected. Although we would have liked to keep the racial groups expanded, there were not enough participants in these groups for statistical power.

Determining Gestational Weight Gain

Gestational weight gain was calculated by self-reported pre-pregnancy weight and last weight recorded by trained medical professionals, taken from EHR. The difference in the time the weight was recorded, and the delivery data was calculated using the participants' gestational age at delivery and due date to calculate the delivery date, and by subtracting the delivery date from the day the weights were taken. If participant’s weights were taken over 14 days from delivery, they were excluded from analyses.

Determining Misalignment Categories

Expected gestational weight gain was collected through the initial survey which asked participants, “how much weight do you think you should be gaining over the course of your pregnancy (in pounds)?” as well as “check all the factors influencing your answer to the previous question?” Possible responses included doctor, personal research, social media, family, friends, partner, or nothing. Misalignment was calculated by taking the participants' expected GWG and comparing it to their actual GWG. If individuals' expectations were within 5lbs of their actual GWG then they were placed in the aligned category. Those whose expectations were 5lbs higher than their actual GWG were assigned into the overestimated category and those with expectations 5lbs lower than actual GWG were placed in the underestimated category.

Assessing Disordered Eating (Outcome Variable)

Disordered Eating symptomatology was measured using the Eating Disorder Examination Questionnaire-Short Form (EDE-QS) 31. The EDE-QS consists of 12 questions and specific behaviors related to eating disorders, like fasting, purging, compulsive exercise, limiting food to control weight and shape, binge eating, and loss of control eating 32. Questions assessing these behaviors are scored from 0 (0 days) to 3 (6-7 days) 33. A sum of the scores at each trimester were calculated to find the disordered eating symptomatology at each trimester. A score of 2 on the EDE-QS was found to be an accurate cut-off based on a score of 4 being the cut-off for the EDE-Q 32. Trimester 3 scores were used for the purpose of this study as disordered eating at the end of pregnancy was the primary outcome.

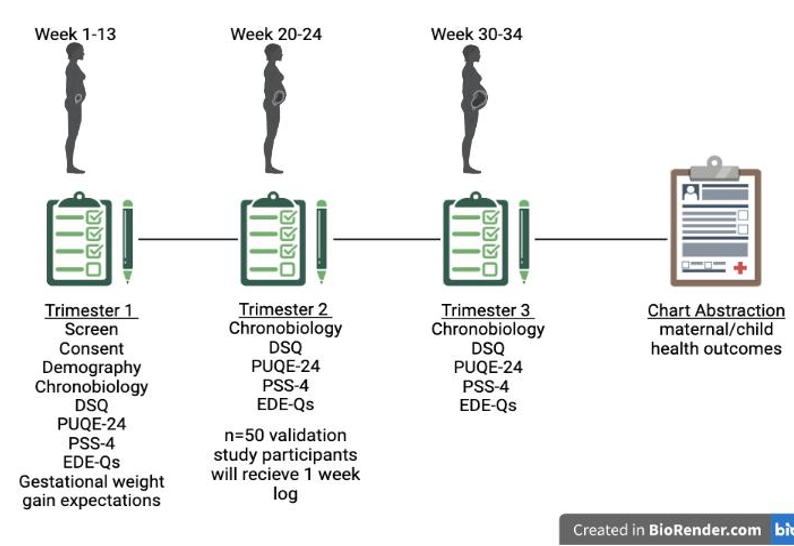
### **Results**

The exposure variable, the participant’s actual gestational weight gain (GWG), was found to be normally distributed (p=0.323 for Shapiro-Wilk test). GWG was compared to possible covariates using linear regression for continuous variables and ANOVA for categorical variables. For categories that had less than 10 individuals within a subcategory, Mann Whitney tests were used to assess differences in GWG. Variables had significant associations with actual GWG if the p-value < 0.1. Significant covariates that had at least 10 individuals per group were considered for multivariate analysis.

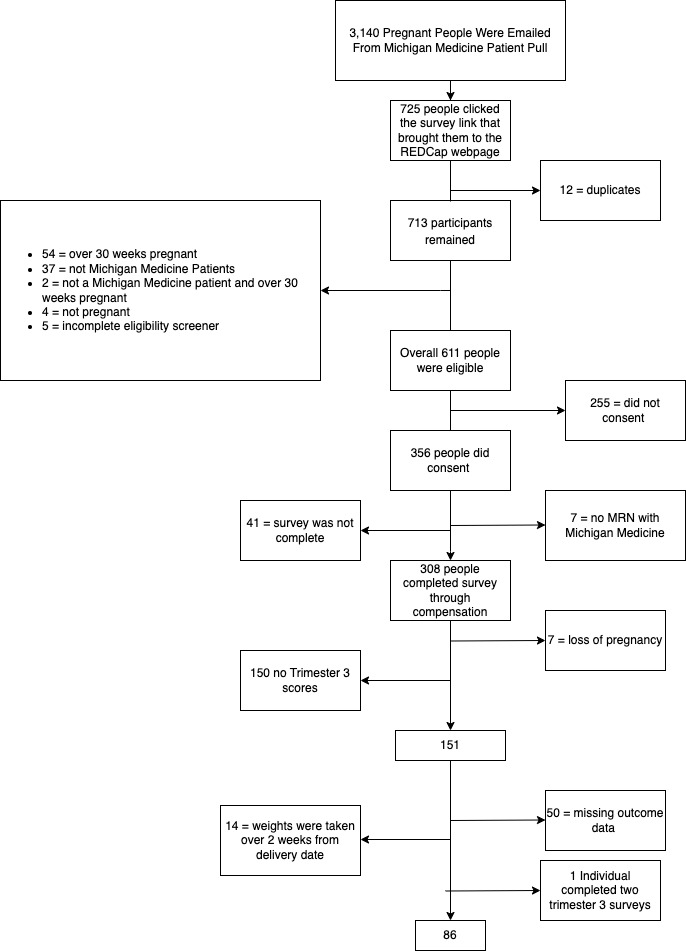
The outcome variable, total EDE-QS score during trimester 3, was calculated by totaling the answers to each individual question from the EDE-QS during trimester 3. Trimester 3 scores were found to be right skewed, where many individuals had a score of zero (p = 0 for Shapiro-Wilk). The mean and variance were found to be different as models tested against EDE-QS scores failed the overdispersion test (p = 0.0004). Because of this, negative binomial multilinear regression was used to model EDE-QS scores. Covariates with a p-value of <0.1 were considered for multivariate analysis.

Alignment categories were compared to demographic variables using ꭓ-squared tests for categorical covariates and ANOVA for the continuous covariates. For categories that had less than 10 individuals within subcategory, Fisher Exact tests were used to assess any relationship with alignment categories. Variables had significant associations with misalignment categories if the p-value < 0.1.

The primary relationship explored for this study was the relationship between GWG and trimester 3 EDE-QS scores. Negative binomial multilinear regression was used to test this relationship. *A priori* covariates were added to the model, including maternal age and parity, followed by sociodemographic characteristics and significant covariates from univariate analyses. Significant models had a p-value <0.5. Once the final adjusted model was determined, misalignment was added as an interaction term to determine if misalignment was an effect modifier of the GWG and EDE-QS association.



**Figure 1**: PRESS study design



**Figure 2:** Flow of participants through the study

## **Results**

**Demographic Characteristics of the PRESS Population**

Figure 1 illustrates the flow of surveys participants in PRESS study completed throughout the time they were enrolled in the study. Every participant completed a screener, consent form, and a demographics survey no matter their gestational age at enrollment. Figure 2 illustrates the flow of participants through the study. 3,140 individuals received an email from the study team to participate in the study. 725 of the people who received a recruitment email clicked on the survey link and began the survey. 12 individuals were found to be duplicates, so this number was corrected to 713 individuals. After completing the screener, 109 individuals were not eligible. Of the remaining 611 participants, 356 individuals consented to complete the study. After completing the first survey, 7 individuals were found to not have valid Michigan Medicine ID’s and 41 participants did not complete the entire first survey and were therefore excluded. Of the 308 individuals who remained, 155 individuals had a trimester 3 score during the time of data abstraction, and 7 participants had a loss of pregnancy. Of the 151 participants remaining, 50 participants did not have completed outcome data and 14 of the participants GWG weights were taken over 2 weeks from delivery. 1 participant was found to have completed two trimester 3 EDE-QS surveys and was therefore excluded as their two scores differed. Therefore, the final sample for this analysis consisted of 86 individuals.



**Table 1:** Demographic characteristics of PRESS population

The final sample of participants used for analysis consisted of pregnant people who were predominantly white, educated, wealthy, within a normal BMI category, married or in a long-term partnership, and did not smoke (Table 1). The average gestational age at enrollment was 18.9 +/- 6.31 weeks. Their expected gestational weight gain was 24.9 +/- 9.26 lbs. The average age was 31.6 +/- 3.84 years old. Trimester 3 EDE-QS scores were on average 3.8 +/- 2.81, and the average GWG for these participants was 30.3 +/- 13.6 lbs. Most participants underestimated their actual GWG (47.7%), followed by aligned GWG (33.7%), and overestimated GWG (18.6%).

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**Table 2:** GWG compared to demographic variables.

Continuous covariates modeled against GWG using linear regression

Discrete covariates modeled against GWG using ANOVA

\*\*Mann-Whitney Test

P-value < 0.1 are bolded.

**GWG Expectations Are Associated with Actual GWG**

Most covariates were not found to be significantly associated with GWG. Individuals who were not White or Caucasian (27.0 lbs.) had a lower mean GWG compared to White and Caucasian participants (30.9 lbs.) (p = 0.3). Household income was also not found to be significantly associated with GWG, however individuals with the lowest income had higher mean GWG (34.1 lbs.) compared to those with an income between $100,000-149,999 and $150,000 or more (26.3 lbs. and 29.8 lbs.) (p =0.2). Participants' pre-pregnancy BMI as well as pre-pregnancy weight was found to be negatively associated with GWG, where a 1 kg/m2increase in BMI was associated with a 0.86 +/- 0.21 lb. decrease in GWG (p= 0.00009), and where a l lb. increase in maternal pre-pregnancy weight was associated with a 0.12 +/- 0.037 lb. decrease in GWG (p =0.0017). Additionally, pre-pregnancy BMI as a discrete variable was also found to be significantly associated with GWG, where the average GWG for the one underweight participant was 30 lbs., normal weight individuals gained on average 33.3 lbs., overweight participants gained on average 33.7 lbs., and obese participants gained on average 22.8 lbs. (p-value 0.012). Expected GWG was positively associated with actual GWG, where a 1 lb. increase in expected GWG was associated with a 0.5 lb. increase in GWG (p= 0.0025). Finally, when participants expected GWG was compared to their actual GWG, those who overestimated their GWG had a lower actual GWG (15.5 lbs.) compared to those who underestimated their GWG (38.8 lbs.), and those whose expectations aligned with their actual GWG gained ( 26.3 lbs.) (p = 2.9e-11) (Table 2).



**Table 3:** EDE-QS Trimester 3 compared to demographic variables.

All variables modeled against EDE-QS tested using Negative Binomial Generalized Linear Models

Increase in EDE-QS=

P-value < 0.1 are bolded.

**Participants With Higher Pre-Pregnancy Weight Have Increased Disordered Eating at Trimester 3**

A few demographic characteristics were found to be significantly associated with EDE-QS at trimester 3 (Table 3). Participant pre-pregnancy BMI was found to have a U-shaped relationship with GWG, where 1 individual who was underweight had a higher disordered eating score at trimester 3 (6) compared to normal weight individuals (1.95) and those who were overweight (4.68) or obese (3.52) had on average higher disordered eating scores in trimester 3 compared to normal weight individuals (p = 0.017). When explored continuously, a 1 kg/m2 increase in pre-pregnancy BMI was associated with a 3% increase in disordered eating at trimester 3 (p = 0.098). PSS and PUQE scores were found to be significantly associated with trimester 3 EDE-QS scores, where a 1 score increase in PSS was associated with an 11% increase in disordered eating at trimester 3 (p = 0.0165) and a 1 score increase in PUQE at trimester 3 was associated with a 17% increase in disordered eating at trimester 3 (p =0.09).

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**Table 4:** Misalignment categories compared to demographic variables.

Continuous covariates modeled against misalignment using ANOVA

Discrete covariates modeled against misalignment using ꭓ-squared tests

\*\*Fisher Exact Test

P-value < 0.1 are bolded.

**Alignment Between Actual and Expected GWG is Not Associated with Most Demographic Characteristics**

Overall, the alignment between expected and actual gestational weight gain was not statistically different from one another in relation to most demographic characteristics collected (Table 4). The only variable that showed a statistically significant difference was expected gestational weight gain (p = 0.097). This was expected due to GWG being used to calculate the alignment categories. Individuals who did not identify as White or Caucasian were more likely to have an expected GWG that was within 5 lbs. of their actual GWG (53.5%) compared to White and Caucasian participants (29.6%), although this difference was not statistically significant (p =0.158). Additionally, on average those who’s expected GWG was either over or under their actual GWG had on average a lower PSS score compared to those with expected GWG within 5 lbs. of their actual GWG (p = 0.401).

**Gestational Weight Gain is Positively Associated with Trimester 3 Disordered Eating**

The unadjusted model of GWG and disordered eating at trimester 3 was positively associated with each other (b=0.01631 (95% CI= 0.997-1.04), p=0.086) (Table 5). When adjusted for covariates chosen *a priori*, the beta-estimate did not substantially change, suggesting that parity and age did not alter the relationship between GWG and disordered eating at the end of pregnancy (p = 0.08) (Table 5). Additionally, when income and race were added to the model, the estimate for GWG did substantially change and neither did the significance of the relationship (p =0.1) (Table 5). In the final model, BMI as a continuous variable was added. By adding BMI as a covariate, the beta coefficient of the relationship between GWG and EDE-QS increased from 0.016 to 0.0281 (95% CI 1.01-1.05) and the p-value also decreased relative to prior models (now p=0.006) (Table 5). In other words, a 10 lb. difference in GWG was associated with a 32% increase in disordered eating at trimester 3. Forest plots comparing the various unadjusted and adjusted models are illustrated in Figure 3. A graphical depiction of model 4 can be seen in Figure 4.

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**Table 5:** Effect of GWG on disordered eating during trimester 3 using negative binomial generalized linear modeling.

P-value <0.05 are bolded.

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**Figure 3**: Forest plot of unadjusted and adjusted models

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**Figure 4:** Negative binomial generalized linear adjusted model of the association between GWG and EDE-QS scores at trimester 3.

\*Model 4 graphed

\*Blue doted lines represent the 95% CI

**A Greater Association Between GWG and Disordered Eating Among Individuals with Aligned GWG**

As alignment of participant’s GWG with their expected GWG was significantly associated with their actual GWG, but not their EDE-QS scores, misalignment was added as a precision covariate to the final adjusted model (Table 5). When this is added to model 4, the effect size increased, however the confidence interval widened slightly. When misalignment was added as an interaction term to test for effect modification, the interaction term was not significant (p = 0.46). Additionally, when comparing the effect modification and model 5 from our previous outcome, the model with the effect modification was not a better predictor of EDE-QS at trimester 3 (p = 0.47 from ANOVA test). Because we hypothesized there would be a difference in risk for EDE-QS among those who underestimated their GWG, we conducted a stratified analysis based on the alignment category. When we stratified our model by the alignment categories; aligned, overestimated, and underestimated, the relationship between GWG and disordered eating at trimester 3 was significant only among participants within the aligned GWG category (b=0.1042 s.e.=0.0338, p =0.0021), compared to the underestimated stratified association (b= 0.0262 s.e.=0.017, p= 0.13), and the overestimated stratified association (b=0.0733 s.e.=0.0679, p= 0.28) (Table 6). Contrary to our hypothesis participants who underestimated their GWG had the smallest GWG estimate (b=0.0262). A forest plot demonstrating the stratified analyses by alignment category is illustrated in Figure 4.



**Table 6:** Adjusted multivariate analyses by misalignment category using negative binomial generalized linear modeling.

\*Adjusted for age, parity, income, and race/ethnicity

P-value <0.05 is bolded.

Chart, box and whisker chart

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**Figure 5:** Forest plot of adjusted models stratified by misalignment.

### **Discussion**

In this observational study of 86 individuals delivering at Michigan Medicine, we found that there was a significant positive association between GWG and disordered eating at trimester 3 (p = 0.006). The population consisted of primarily White/Caucasian, high income, educated, married or in a long-term relationship, and non-smoking pregnant individuals. After adjusting for covariates, we saw that a 10 lb. increase in GWG was associated with a 32% increase in disordered eating during the last trimester of pregnancy. Pre-pregnancy BMI was the only covariate that strengthened the relationship between GWG and disordered eating during trimester 3, which was expected based on univariate analyses and the strong association between BMI with both our exposure and outcome variables. When testing for effect modification of misalignment, the interaction term was not significant (p-value=0.46). However, due to the primary hypothesis that there would be a difference in the effect of GWG and disordered eating at trimester 3 depending on the alignment of expectations and actual GWG, stratified models around misalignment were explored. There was some evidence that those in the aligned category, meaning their expectations were within 5 lbs. of their actual GWG, had higher disordered eating at trimester 3 (b= 0.1042, p = 0.0021), compared to those who underestimated (b= 0.0262, p =0.13) and overestimated (0.0733, p = 0.28) their GWG, however the sample size was small within each category and CI were overlapping. Contrary, to the original hypothesis, those who underestimated their GWG produced the smallest association between GWG and disordered eating at trimester 3 (b=0.0262).

Many other studies have examined how disordered eating is associated with GWG 18,20,21,23,34–36, however the direction of association in this study differs in that we tested the effect that GWG has on disordered eating late in pregnancy. No studies, to our knowledge, have examined the mental health impacts of gestational weight gain guidelines, specifically disordered eating, however studies have shown that pregnant individuals have a fear of gaining weight during pregnancy 37. Since we had data on trimester 2 EDE-QS scores on some individuals within our sample, we were able to assess whether trimester 2 EDE-QS scores impacted the relationship between GWG and trimester 3 EDE-QS scores. When adding trimester 2 scores to our model we noticed that these scores were possibly mediating the relationship between GWG and EDE-QS at trimester 3. The effect estimates for GWG in the relationship between GWG and trimester 2 EDE-QS was 0.0282 using a fully adjusted model, which was similar to the effect estimate using trimester 3 scores, 0.0281. Therefore, the relationship is most likely that disordered eating is driving the association with GWG, like many studies have found. However, to fully understand the directionality of this association, data on pre-pregnancy disordered eating would be preferred.

Pre-pregnancy BMI was found to confound the relationship between GWG and disordered eating, which is consistent with the knowledge that GWG differs by BMI category, most likely driven by NAM guidelines being described in this way, and that those in higher pre-pregnancy BMI categories have more disordered eating 21,22. Originally, I hypothesized that parity would have been a significant covariate, as I thought that pregnant individuals who had experience with a prior pregnancy may be more familiar with GWG, and body changes associated with pregnancy and therefore experience less disordered eating later in pregnancy. This was also predicted to be true for maternal age, where older participants may have also been more likely to have had previous pregnancies and therefore may have been more familiar with body changes during pregnancy. Additionally, previous studies have also adjusted for maternal age and parity 21,34,35, where one study saw pregnant individuals concerned about body shape tended to be younger and nulliparous 38. Instead in this population we observed no difference in either GWG and EDE-QS scores based on parity or age. PSS and PUQE scores were not included in this analysis because although they were both associated with disordered eating, they were not associated with GWG in our sample. Finally, race/ethnicity and income, although not associated with either GWG or EDE-QS at trimester 3 were included to account for any socio-demographic differences within our population.

The analysis involving misalignment between expected GWG and actual GWG is a relatively novel concept. One study that examined the relationship between personal and provider GWG goals defined a difference of 5lbs, which is the way we grouped our misalignment categories 29. Other studies that examined expectations around GWG relative to NAM guidelines saw that pre-pregnancy BMI influenced expectations, where individuals with overweight and obesity more often expected to gain more than NAM guidelines 28,39. There have not been any studies, to the best of our knowledge, that look at the relationship between our misalignment categories and disordered eating outcomes in pregnancy. However, in one study over half of pregnant individuals who wished to maintain their GWG below a certain weight had lower GWG compared to those with less stringent notions around GWG 40. Contrary to our hypothesis, individuals who had expectations lower than their actual GWG had the smallest effect of GWG on disordered eating in trimester 3, and those in the aligned category had the highest and only significant association. One reason for this could be that individuals maintain those expectations may engage in more disordered eating achieve their expectations. However, since sample sizes are small and CI are overlapping, within our categories, it is hard to draw any conclusions. I hope to explore any effect of misalignment further with a greater sample size.

The findings from this study have shed light on the impact that GWG has on disordered eating late in pregnancy, and therefore the effect that GWG may have on disordered eating postpartum. This is worrisome because disordered eating during pregnancy can progress postpartum and potentially lead to self-esteem issues for the pregnant individuals. One study saw that only 50% of obstetricians and gynecologists thought that disordered eating assessment did not fall within their responsibility even though a majority of them understand the physical consequences associated with eating disorders 41. Additionally, the lack of a screening tool that can clearly identify disordered eating during pregnancy leaves many pregnant individuals who do not fit into specific DSM V eating disorder categories unidentified, perpetuating negative health outcomes of disordered eating. Furthermore, the focus on obesity in public health throughout the past 50 years has led to weight normative gestational weight gain guidelines for pregnant people, and consequently less recognition of disordered eating concerns in primarily higher weight individuals due to stigma 42. As such, the NAM guidelines, which inform pregnant individuals on how much weight they should be gaining, may have an unintended outcome of increased disordered eating late in pregnancy. This may be especially problematic among pregnant individuals who set weight gain expectations and potentially use disordered eating tendencies to maintain their expectations or to achieve a gestational weight gain that is lower than their expectations. I hope more research will be done to examine the stratified associations that are occurring between misalignment categories, and as more participants enter in the PRESS cohort, analyses will be reassessed to achieve more statistical power.

The strengths of this study include that multiple surveys were collected for each individual and many covariates were tested against GWG, EDE-QS at trimester 3, and misalignment categories. Additionally, with a small sample size, associations were still found between GWG and DE at trimester 3. In the future, the PRESS cohort will be gaining more participation and therefore this analysis will be conducted with a larger participant pull, and hopefully provide more power with our analyses.

The first limitation to this study was that pre-pregnancy weight as well as gestational age at consent was self-reported. Although the study team was able to confirm gestational age through medical records, pre-pregnancy weight was not confirmed, and the study’s results rely on this measurement to be accurate. Studies have shown that when EHR weights are not able to be collected, self-reported pre-pregnancy weights are a viable option, where one study saw less than a 2 kg difference between actual recorded trimester 1 weights and self-reported weights 43. A second limitation to our study was that we did not have every participant's EDE-QS scores throughout their pregnancy or their baseline EDE-QS scores from prior to pregnancy. This limitation is also pertinent to our variable expectation on GWG. Because some of the participants in this sample entered the study in their second or third trimester, their expectations were also collected during that time, meaning they had already gained weight from their pregnancy, possibly biasing their responses. Once more outcome data is collected on PRESS participants, this will no longer be a limitation as more individuals will have entered in their first trimester. Thirdly, due to the recent use of EDE-QS, it has not been used on a pregnant population. However, the EDE-QS has been shown to be just as effective as the full EDE-Q and a useful measure in pregnancy due to no other measures having been validated 33,44. After recruitment for the study began, a new screening tool was developed to identify eating disorders throughout pregnancy, the Prenatal Eating Behaviors Screening Tool (PEBS) 45. However, the tool may have issues with scale homogeneity and was validated with a majority white population, and still needs further development and validation 45. A further limitation to the study was that actual GWG was collected through medical records and last weight recorded during pregnancy. Since not every individual’s weight was taken at the same time there may be discrepancies in GWG based on when this data was collected from EHR. However, EHR weights were taken on average 3.54 +/- 3.1 days before delivery. Lastly, the sample was primarily white, educated and had higher income, meaning data from the sample may not be representative of populations outside of our sample. I hope further research is conducted to examine this association between GWG and disordered eating late in pregnancy, adjusting for pre-pregnancy disordered eating, as well as reassessing whether maintaining expectations impacts this relationship.

Findings from this study have demonstrated that there is a relationship between GWG and disordered eating during the last trimester of pregnancy. Additionally, individuals who have aligned expectations with their actual GWG have a stronger positive association between GWG and disordered eating, compared to individuals who over- or underestimated their actual GWG. Interventions aimed at detecting disordered eating during all timepoints during pregnancy should be introduced as well as discussion around GWG in relation to NAM guidelines may need to be reevaluated based on the associated mental health consequences.

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**Works Cited**

1. Rasmussen KM, Catalano PM, Yaktine AL. New guidelines for weight gain during pregnancy: what obstetrician/gynecologists should know. *Curr Opin Obstet Gynecol*. 2009;21(6):521-526. doi:10.1097/GCO.0b013e328332d24e

2. Hamad R, Cohen AK, Rehkopf DH. Changing national guidelines is not enough: the impact of 1990 IOM recommendations on gestational weight gain among US women. *Int J Obes 2005*. 2016;40(10):1529-1534. doi:10.1038/ijo.2016.97

3. Rogozińska E, Zamora J, Marlin N, et al. Gestational weight gain outside the Institute of Medicine recommendations and adverse pregnancy outcomes: analysis using individual participant data from randomised trials. *BMC Pregnancy Childbirth*. 2019;19(1):322. doi:10.1186/s12884-019-2472-7

4. Vehmeijer FOL, Balkaran SR, Santos S, et al. Psychological Distress and Weight Gain in Pregnancy: a Population-Based Study. *Int J Behav Med*. 2020;27(1):30-38. doi:10.1007/s12529-019-09832-0

5. Farias DR, Carrilho TRB, Freitas-Costa NC, Batalha MA, Gonzalez M, Kac G. Maternal mental health and gestational weight gain in a Brazilian Cohort. *Sci Rep*. 2021;11(1):10787. doi:10.1038/s41598-021-90179-6

6. Athar U, Daud NUA, Khan WA, Khalid A, Gill SI. Caught Between External Pressures and Internal Battles: Psychosocial Factors Affecting Gestational Weight Gain - A Scoping Review. *Cureus*. 2021;13(2):e13487. doi:10.7759/cureus.13487

7. Charbonneau KD, Seabrook JA. Adverse Birth Outcomes Associated with Types of Eating Disorders: A Review. *Can J Diet Pract Res Publ Dietit Can Rev Can Prat Rech En Diet Une Publ Diet Can*. 2019;80(3):131-136. doi:10.3148/cjdpr-2018-044

8. Linna MS, Raevuori A, Haukka J, Suvisaari JM, Suokas JT, Gissler M. Pregnancy, obstetric, and perinatal health outcomes in eating disorders. *Am J Obstet Gynecol*. 2014;211(4):392.e1-392.e8. doi:10.1016/j.ajog.2014.03.067

9. Bulik CM, Von Holle A, Hamer R, et al. Patterns of remission, continuation and incidence of broadly defined eating disorders during early pregnancy in the Norwegian Mother and Child Cohort Study (MoBa). *Psychol Med*. 2007;37(8):1109-1118. doi:10.1017/S0033291707000724

10. Anderson M. What is Disordered Eating? Academy of Nutrition and Dietetics. Published October 26, 2018. Accessed February 5, 2022. https://www.eatright.org/health/diseases-and-conditions/eating-disorders/what-is-disordered-eating

11. Abraham S, King W, Llewellyn-Jones D. Attitudes to body weight, weight gain and eating behavior in pregnancy. *J Psychosom Obstet Gynaecol*. 1994;15(4):189-195. doi:10.3109/01674829409025645

12. Vanderkruik R, Ellison K, Kanamori M, Freeman MP, Cohen LS, Stice E. Body dissatisfaction and disordered eating in the perinatal period: an underrecognized high-risk timeframe and the opportunity to intervene. *Arch Womens Ment Health*. 2022;25(4):739-751. doi:10.1007/s00737-022-01236-6

13. Broussard B. Psychological and behavioral traits associated with eating disorders and pregnancy: a pilot study. *J Midwifery Womens Health*. 2012;57(1):61-66. doi:10.1111/j.1542-2011.2011.00089.x

14. Martínez-Olcina M, Rubio-Arias JA, Reche-García C, et al. Eating Disorders in Pregnant and Breastfeeding Women: A Systematic Review. *Med Kaunas Lith*. 2020;56(7):352. doi:10.3390/medicina56070352

15. Swann RA, Von Holle A, Torgersen L, Gendall K, Reichborn-Kjennerud T, Bulik CM. Attitudes toward weight gain during pregnancy: results from the Norwegian mother and child cohort study (MoBa). *Int J Eat Disord*. 2009;42(5):394-401. doi:10.1002/eat.20632

16. Stein A, Murray L, Cooper P, Fairburn CG. Infant growth in the context of maternal eating disorders and maternal depression: a comparative study. *Psychol Med*. 1996;26(3):569-574. doi:10.1017/s0033291700035649

17. Watson HJ, Zerwas S, Torgersen L, et al. Maternal eating disorders and perinatal outcomes: A three-generation study in the Norwegian Mother and Child Cohort Study. *J Abnorm Psychol*. 2017;126(5):552-564. doi:10.1037/abn0000241

18. Micali N, Al Essimii H, Field AE, Treasure J. Pregnancy loss of control over eating: a longitudinal study of maternal and child outcomes. *Am J Clin Nutr*. 2018;108(1):101-107. doi:10.1093/ajcn/nqy040

19. Fealy S, Leigh L, Hazelton M, et al. Translation of the Weight-Related Behaviours Questionnaire into a Short-Form Psychosocial Assessment Tool for the Detection of Women at Risk of Excessive Gestational Weight Gain. *Int J Environ Res Public Health*. 2021;18(18):9522. doi:10.3390/ijerph18189522

20. Park CK, Krebs L, Lutsiv O, et al. Binge Eating Predicts Excess Gestational Weight Gain: A Pilot Prospective Cohort Study. *J Obstet Gynaecol Can JOGC J Obstet Gynecol Can JOGC*. 2015;37(6):494-507. doi:10.1016/s1701-2163(15)30226-7

21. Mumford SL, Siega-Riz AM, Herring A, Evenson KR. Dietary restraint and gestational weight gain. *J Am Diet Assoc*. 2008;108(10):1646-1653. doi:10.1016/j.jada.2008.07.016

22. Zanardo V, Volpe F, Giliberti L, et al. Prepregnancy Body Mass Index shift across gestation: primary evidence of an association with eating disorders. *J Matern-Fetal Neonatal Med Off J Eur Assoc Perinat Med Fed Asia Ocean Perinat Soc Int Soc Perinat Obstet*. 2020;33(3):415-420. doi:10.1080/14767058.2018.1494709

23. Zanardo V, Cavaliere A, Giliberti E, et al. Gestational weight gain and eating-related disorders. *J Obstet Gynaecol*. Published online March 5, 2021:1-9. doi:10.1080/01443615.2020.1854699

24. Chan CY, Lee AM, Koh YW, et al. Course, risk factors, and adverse outcomes of disordered eating in pregnancy. *Int J Eat Disord*. 2019;52(6):652-658. doi:10.1002/eat.23065

25. Lovering ME, Rodgers RF, George JE, Franko DL. Exploring the Tripartite Influence Model of body dissatisfaction in postpartum women. *Body Image*. 2018;24:44-54. doi:10.1016/j.bodyim.2017.12.001

26. Astrachan-Fletcher E, Veldhuis C, Lively N, Fowler C, Marcks B. The reciprocal effects of eating disorders and the postpartum period: a review of the literature and recommendations for clinical care. *J Womens Health 2002*. 2008;17(2):227-239. doi:10.1089/jwh.2007.0550

27. Hill B, Hayden M, McPhie S, Bailey C, Skouteris H. Preconception and antenatal knowledge and beliefs about gestational weight gain. *Aust N Z J Obstet Gynaecol*. 2019;59(5):634-640. doi:10.1111/ajo.12942

28. Krukowski RA, West DS, DiCarlo M, Cleves MA, Saylors ME, Andres A. Association of Gestational Weight Gain Expectations and Advice on Actual Weight Gain. *Obstet Gynecol*. 2017;129(1):76-82. doi:10.1097/AOG.0000000000001780

29. Bodnar LM, Abrams B, Simhan HN, et al. The impact of setting a pregnancy weight gain goal on total weight gain. *Paediatr Perinat Epidemiol*. 2021;35(2):164-173. doi:10.1111/ppe.12724

30. O’Loghlen E, Galligan R. Disordered eating in the postpartum period: Role of psychological distress, body dissatisfaction, dysfunctional maternal beliefs and self-compassion. *J Health Psychol*. Published online February 16, 2021:1359105321995940. doi:10.1177/1359105321995940

31. Gideon N, Hawkes N, Mond J, Saunders R, Tchanturia K, Serpell L. Correction: Development and Psychometric Validation of the EDE-QS, a 12 Item Short Form of the Eating Disorder Examination Questionnaire (EDE-Q). *PloS One*. 2018;13(11):e0207256. doi:10.1371/journal.pone.0207256

32. Hahn SL, Kaciroti N, Eisenberg D, Weeks HM, Bauer KW, Sonneville KR. Introducing Dietary Self-Monitoring to Undergraduate Women via a Calorie Counting App Has No Effect on Mental Health or Health Behaviors: Results From a Randomized Controlled Trial. *J Acad Nutr Diet*. Published online August 2021:S2212267221007346. doi:10.1016/j.jand.2021.06.311

33. Prnjak K, Mitchison D, Griffiths S, et al. Further development of the 12-item EDE-QS: identifying a cut-off for screening purposes. *BMC Psychiatry*. 2020;20(1):146. doi:10.1186/s12888-020-02565-5

34. Sámano R, Ortiz-Hernández L, Martínez-Rojano H, et al. Disordered Eating Behaviors Are Associated with Gestational Weight Gain in Adolescents. *Nutrients*. 2021;13(9):3186. doi:10.3390/nu13093186

35. Hecht LM, Schwartz N, Miller-Matero LR, Braciszewski JM, Haedt-Matt A. Eating pathology and depressive symptoms as predictors of excessive weight gain during pregnancy. *J Health Psychol*. Published online April 17, 2020:1359105320913934. doi:10.1177/1359105320913934

36. Siega-Riz AM, Bodnar LM, Stotland NE, Stang J. The Current Understanding of Gestational Weight Gain Among Women with Obesity and the Need for Future Research. *NAM Perspect*. 2020;2020. doi:10.31478/202001a

37. Czech-Szczapa B, Szczapa T, Merritt TA, et al. Disordered eating attitudes during pregnancy in mothers of newborns requiring Neonatal Intensive Care Unit admission: a case control study. *J Matern-Fetal Neonatal Med Off J Eur Assoc Perinat Med Fed Asia Ocean Perinat Soc Int Soc Perinat Obstet*. 2015;28(14):1711-1715. doi:10.3109/14767058.2014.966675

38. J-P NA, Minami M, Eitoku M, et al. Lack of concern about body image and health during pregnancy linked to excessive gestational weight gain and small-for-gestational-age deliveries: the Japan Environment and Children’s Study. *BMC Pregnancy Childbirth*. 2021;21(1):396. doi:10.1186/s12884-021-03827-0

39. Wang ML, Arroyo J, Druker S, Sankey HZ, Rosal MC. Knowledge, Attitudes and Provider Advice by Pre-Pregnancy Weight Status: A Qualitative Study of Pregnant Latinas With Excessive Gestational Weight Gain. *Women Health*. 2015;55(7):805-828. doi:10.1080/03630242.2015.1050542

40. Ogawa K, Morisaki N, Sago H, Fujiwara T, Horikawa R. Association between women’s perceived ideal gestational weight gain during pregnancy and pregnancy outcomes. *Sci Rep*. 2018;8(1):11574. doi:10.1038/s41598-018-29936-z

41. Leddy MA, Jones C, Morgan MA, Schulkin J. Eating disorders and obstetric-gynecologic care. *J Womens Health 2002*. 2009;18(9):1395-1401. doi:10.1089/jwh.2008.1183

42. Bye A, Shawe J, Bick D, Easter A, Kash-Macdonald M, Micali N. Barriers to identifying eating disorders in pregnancy and in the postnatal period: a qualitative approach. *BMC Pregnancy Childbirth*. 2018;18(1):114. doi:10.1186/s12884-018-1745-x

43. Rangel Bousquet Carrilho T, M Rasmussen K, Rodrigues Farias D, et al. Agreement between self-reported pre-pregnancy weight and measured first-trimester weight in Brazilian women. *BMC Pregnancy Childbirth*. 2020;20(1):734. doi:10.1186/s12884-020-03354-4

44. Bannatyne AJ, McNeil E, Stapleton P, MacKenzie-Shalders K, Watt B. Disordered eating measures validated in pregnancy samples: a systematic review. *Eat Disord*. 2021;29(4):421-446. doi:10.1080/10640266.2019.1663478

45. Claydon EA, Lilly CL, Ceglar JX, Dueñas-Garcia OF. Development and validation across trimester of the Prenatal Eating Behaviors Screening tool. *Arch Womens Ment Health*. 2022;25(4):705-716. doi:10.1007/s00737-022-01230-y