

PRENATAL WEIGHT GAIN:
THE RELATIONSHIP BETWEEN FOOD CRAVINGS AND WEIGHT GAIN

by

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ABSTRACT

Interventions to date have been minimally effective in reducing the rates of women gaining more weight than recommended by the Institute of Medicine in pregnancy. Food cravings are common in pregnancy, but their relationship, if any, with prenatal weight gain has received little attention in the literature. The purpose of this retrospective chart review study was to describe the frequency of cravings, associations between cravings and weight gain, and to determine what factors were predictive of reporting more cravings in pregnancy. A total of 1,259 charts were reviewed of women receiving care in an urban, community health center between 2006 and 2012. Women with healthy, singleton pregnancies were eligible to be included in the study. Of the 812 eligible women, 620 were excluded due to incomplete data. One-third of women in the sample ($n = 194$) were primiparous women. Their mean BMI was 28.3 ($SD = 6.9$). Almost 80% identified themselves as being Multi-Racial or African American.

Cravings were reported by 75.3% of women in early pregnancy and 81.4% in late pregnancy. No differences in prenatal weight gain were seen between women with and without cravings. BMI, smoking, stress in early pregnancy, and emotional distress were not related to the numbers of cravings reported in pregnancy. The results of multiple regression analyses indicated that two predictors, age and stress in late pregnancy, accounted for 8.7% of the variance in the numbers of cravings reported in pregnancy ($R^2 = .087$, $R^2_{\text{adjusted}} = .070$, $F(2, 108) = 5.14$, $p = .007$). Younger age was associated with reporting a greater number of cravings, $\beta = -.205$, $t(110) = -2.222$, $p = .028$, as was higher stress in late pregnancy, $\beta = .201$, $t(110) = 2.184$, $p = .031$.

The findings of this study suggest that cravings are not related to prenatal weight gain, although the quality of this study was undermined by its small sample size and problems with the way cravings were measured. Developing a valid and reliable measure of cravings would be a fruitful next step.

CHAPTER 1 INTRODUCTION

Nearly 50% of pregnant women gain more weight during pregnancy than recommended by the Institute of Medicine (IOM) (Dalenius, Brindley, Smith, Reinold, & Grummer-Strawn, 2012). Excessive prenatal weight gain as defined by the 2009 IOM guidelines differs by baseline BMI; normal weight women are advised to gain between 25 and 35 pounds (lbs), overweight women between 15 and 25 lbs, and obese women between 10 and 20 lbs (Institute of Medicine & National Research Council, 2009). Gaining more than recommended is associated with significant increased risks of perinatal complications and long-term morbidities for women and their children (Margerison Zilko, Rehkopf, & Abrams, 2010; Siega-Riz et al., 2009). Unfortunately, interventions tested to date have resulted in little improvement in adherence to weight gain recommendations (Gardner, Wardle, Poston, & Croker, 2011; Streuling et al., 2011; Streuling, Beyerlein, & von Kries, 2010). Consequently, a better understanding of the factors associated with excessive weight gain is an essential precursor to developing more effective interventions. Although many expectant mothers experience cravings, there has been little research to assess the contributions of cravings to excessive prenatal weight gain. The purpose of this retrospective chart review study was to describe the frequency of cravings in pregnancy, the associations between cravings and prenatal weight gain, and to determine what factors were predictive of a greater number of cravings in pregnancy.

Significance

Prenatal weight gain is associated with difficulty in returning to a woman's weight prior to the pregnancy, with consequent negative health outcomes for both mother and baby. Gaining more weight than recommended in pregnancy is one of the most important independent risk factors of being ≥ 5 kilogram (kg) heavier at one year postpartum than before pregnancy; this magnitude of postpartum weight retention affects 13% to 20% of women (Gunderson, 2009). Risk of postpartum weight retention increases with higher prenatal weight gain. For example, risks of retaining ≥ 5 kg at six months postpartum were six times higher for women gaining ≥ 20 kg in pregnancy compared to those women

who gained between 10 and 15 kg (Olson, Strawderman, & Dennison, 2009). Overweight and obese women are more likely to experience significant postpartum weight retention compared to women of normal weight (Oken, Kleinman, Belfort, Hammitt, & Gillman, 2009; Olson et al., 2009). Several longitudinal studies following women for 15 years or more after birth have reported that excessive prenatal weight gain is significantly associated with being overweight or obese 15 years or more after birth (Amorim, Rossner, Neovius, Lourenco, & Linne, 2007; Mamun et al., 2010). A meta-analysis of 12 studies reported that women gaining above the upper limit of the recommended weight range set by the IOM were 3.15 kg, 95% CI [2.47, 3.82], heavier than women gaining within the recommended ranges at 21 years postpartum (Mannan, Doi, & Mamun, 2013). In turn, becoming overweight or obese is associated with significantly greater risks of developing future diabetes and cardiovascular disease (Feig, Zinman, Wang, & Hux, 2008; Field et al., 2001).

Infants born to mothers who exceed recommended weight gain guidelines are also at increased risk of developing obesity. In a longitudinal study of mother-infant pairs ($N = 208$), infants born to mothers who gained more than recommended by the IOM were at increased risk of being overweight at age three compared to infants born to women who adhered to prenatal weight gain guidelines (Olson et al., 2009). These findings were confirmed in a meta-analysis of 15 studies which reported an increased likelihood of childhood obesity in children born to women who gained above, compared to those that gained within, the weight gain ranges set by the IOM, OR 1.33, 95% CI [1.18, 1.50] (Tie et al., 2014).

Similar findings were also reported in another longitudinal study with even longer follow-up. Excessive maternal weight gain was significantly correlated with measurements of adiposity in a longitudinal study of adults aged 27 to 30 years ($N = 276$) exposed to excessive maternal weight gain in-utero; $r = 0.26, p < 0.001$ for percentage of body fat, $r = 0.26, p < 0.001$ for waist circumference, and $r = 0.26, p < 0.001$ for BMI after controlling for age, sex, social class, smoking status, and physical activity level (Reynolds, Osmond, Phillips, & Godfrey, 2010).

Further, excessive weight gain increases the risk of immediate complications during pregnancy and delivery such as preeclampsia, gestational diabetes (GDM), genital lacerations, and operative delivery (Albers, Greulich, & Peralta, 2006; Fortner, Pekow, Solomon, Markenson, & Chasan-Taber, 2009; Hedderson, Gunderson, & Ferrara, 2010; Johnson et al., 2013; Kieffer et al., 2006; Rodrigues, de Oliveira, Brito Ados, & Kac, 2010; Tovar, Must, Bermudez, H, & Chasan-Taber, 2009; Walker, Hoke, & Brown, 2009). It doubles the risk of delivering a large-for-gestational age infant (Kim, Sharma, Sappenfield, Wilson, & Salihu, 2014). These risks are higher for overweight and obese women in general and higher yet if they gain more weight than recommended in pregnancy (Crane, White, Murphy, Burrage, & Hutchens, 2009; Johnson et al., 2013; Kim et al., 2014; Nohr et al., 2008). Thus, excessive prenatal weight gain increases the risk for the development or worsening of obesity for women, and their children, if they are exposed to excessive maternal weight gain in-utero. In turn, obesity increases the risk of future diabetes and cardiovascular disease.

Excessive weight gain in pregnancy affects almost 50% of pregnant women. In 2010 only 30.6% of the over 1.2 million pregnant women followed by the Pediatric and Pregnancy Nutrition Surveillance System gained weight appropriately; 21.5% gained less, and 48% gained more, than recommended (Dalenius et al., 2012). Not only is excessive weight gain the most common pattern, but heavier women are the most likely to be affected. Large cohort studies have reported that 18% to 52% of normal weight women compared to 41% to 73% of overweight women gain more than recommended by 1990 IOM guidelines (Brawarsky et al., 2005; Cheng et al., 2008). Similar patterns have been seen in cohort studies using the criteria set by the new IOM 2009 guidelines. More overweight women, than normal and underweight women, exceed the upper allowable weight limit set by the IOM (Gould Rothberg, Magriples, Kershaw, Rising, & Ickovics, 2011; Johnson et al., 2013; Park et al., 2011). The 2009 IOM guidelines set a recommended weight range for obese mothers for the first time; observational studies using these criteria report that 55% to 74.6% of obese women gain too much weight in pregnancy (Dalenius et al., 2012; Gould Rothberg et al., 2011; Johnson et al., 2013; Park et al., 2011).

Avoiding the risks associated with excessive prenatal weight gain requires understanding factors, such as cravings, which may contribute to excessive weight gain in pregnancy. However, only three studies have addressed the relationships between food cravings and dietary intake in pregnancy (Belzer, Smulian, Lu, & Tepper, 2010; Pope, Skinner, & Carruth, 1992; Tierson, Olsen, & Hook, 1985). Two have examined the relationships between cravings and prenatal weight gain. While the results of the two studies on the associations between cravings and prenatal weight gain are difficult to interpret, given problems with their methodology, both studies reported higher weight gain in women with cravings compared to those without cravings (Allison, Wrotniak, Par'ce, & Sarwer, 2012; Hill & McCance, 2014).

Background

Why some women gain weight in excess of recommendations is little understood. It may be that certain women have a higher risk of experiencing cravings, which may trigger higher consumption of desired foods and result in excessive prenatal weight gain. Personal characteristics, such as cigarette smoking, higher BMI, or eating as a way to cope with stress or depression, may be associated with greater cravings and excessive weight gain. The following section summarizes the background needed to understand the proposed relationships between these risk factors, food cravings, dietary intake, and prenatal weight gain. These relationships are depicted in Figure 1.

Risk Factors

Because cravings are so common in pregnancy, they may occur in response to physiologic changes in pregnancy. The underlying physiology of appetite regulation, particularly in pregnancy, is poorly understood. Pregnancy is associated with leptin and insulin resistance (Hamed, Zakary, Ahmed, & Gamal, 2011; Newbern & Freemark, 2011). Leptin and insulin are known to act centrally to suppress appetite in non-pregnant individuals. Therefore, the resistance to insulin and leptin seen in normal pregnancy may undermine the ability of these hormones to suppress appetite in pregnancy and play a role in the increase in hunger and food cravings reported by many pregnant women. Cravings may then help ensure that the mother consumes sufficient calories to meet the needs of the developing fetus.

However, cravings may be more pronounced in pregnant women with a higher BMI. Obesity is known to be associated with leptin and insulin resistance (Hamed et al., 2011). Women who are obese before pregnancy are likely to have higher baseline levels of leptin and insulin resistance and may experience greater hunger and cravings than women of healthy weight in pregnancy. Food cravings have been reported to be positively correlated with higher BMI in several cross-sectional studies of non-pregnant women (Burton, J. Smit, & J. Lightowler, 2007; Franken & Muris, 2005; White, Whisenhunt, Williamso, Greenway, & Netemeyer, 2002).

Women enter pregnancy with already established patterns of behavior. Cravings in pregnancy may therefore be indicative of unhealthy pre-pregnancy behaviors such as smoking or emotional eating. Food cravings are more frequent in smokers compared to non-smokers (Dickens & Trethowan, 1971; Pepino, Finkbeiner, & Mennella, 2009) and in those that eat in response to stress compared to those who cope with stress in more healthy ways (Burton et al., 2007). Cross-sectional surveys in pregnant women have reported poorer quality dietary intake in pregnant women experiencing higher levels of emotional distress (Fowles, Bryant, et al., 2011; Lobel et al., 2008). Since cravings are a common feature of emotional eating, it may be that cravings in pregnancy are more numerous and persistent in women who are depressed or under higher levels of stress (Burton et al., 2007).

Food Cravings

Cravings occur in the majority of pregnant women (Dickens & Trethowan, 1971; Pope et al., 1992). Cravings increase in pregnancy, generally peak in the first half of pregnancy, and often persist for several months or more before fading away (Belzer et al., 2010; Tierson et al., 1985). The most commonly reported cravings are for sweets, fruit and fruit juice, and dairy products (Finely, Dewey, Lonnerdal, & Grivetti, 1985; Hook, 1978; Pope et al., 1992).

Only three studies have been conducted to date on the relationships between cravings and dietary intake in pregnancy. Researchers have reported an association between food cravings and higher intakes of craved foods in two studies (Pope et al., 1992; Tierson et al., 1985), but not in a third (Belzer et al.,

2010). Higher intakes in early pregnancy of dairy products (Olafsdottir, Skuladottir, Thorsdottir, Hauksson, & Steingrimsdottir, 2006), fast food (Uusitalo et al., 2009) and sweets (Olafsdottir et al., 2006) are significantly correlated with higher prenatal weight gain in cross-sectional studies. These same foods are among the most common food items pregnant women report craving (Finely et al., 1985; Hook, 1978; Pope et al., 1992). Other researchers reported that women who perceived that they were “eating a lot more” in pregnancy gained significantly more weight in pregnancy than those who increased their intake to a lesser extent (Olafsdottir et al., 2006; Olson & Strawderman, 2003). Cravings could potentially prompt women to consume more food in pregnancy and gain a greater amount of weight compared to women without cravings.

A paucity of research has investigated the relationships between cravings and prenatal weight gain. Only two studies have been conducted to date. Both reported an association between cravings and higher weight gain, but their results are widely disparate. One study reported a one kilogram increase in prenatal weight gain in Irish women ($N = 1,639$) with cravings compared to those without cravings (Hill & McCance, 2014). Allison, Wrotniak, Par’e, and Sarwer (2012) reported that a one-unit increase on a craving scale was associated with a 5.1 kg increase in prenatal weight in a sample of African American women ($N = 120$).

Thus cravings may be a normal physiologic response to pregnancy. However, they also may be more prevalent in women who are overweight or obese before pregnancy, who currently smoke cigarettes, or who are experiencing high levels of depression and stress. Cravings, no matter what the underlying cause, could be associated with increasing dietary intake, which in turn could be associated with excessive weight gain. Understanding whether cravings are related to prenatal weight gain and if so, in which specific populations, would allow more effective targeted interventions to be developed and tested.

Prenatal Weight Gain

The IOM released guidelines on prenatal weight gain first in 1990 and then again in 2009. All women are advised to gain a minimal amount of weight in the first trimester of pregnancy, thereafter the

amount of weight a woman is recommended to gain depends on her pre-pregnancy BMI. Allowable weight gain is in inverse relationship to BMI; the heavier the woman, the less weight she is recommended to gain. Table 1 describes the weight ranges recommended by the IOM 2009 guidelines by BMI category (i.e., underweight, normal weight, overweight, and obese).

Table 1

IOM 2009 Weight Guidelines, Recommended Weight Gain by BMI

BMI Categories		First Trimester	Weekly Gain	Total Weight Gain
	kg/m ²	lbs	lbs	lbs
Underweight	<18.5	1.1 - 4.4	1 - 1.3	28 -40
Normal Weight	18.5-24.9	1.1 - 4.4	0.8 - 1	25-35
Overweight	25-29.9	1.1 - 4.4	0.5 - 0.7	15-25
Obese	≥ 30.0	1.1 - 4.4	0.4 - 0.6	11-20

Note. IOM (2009) Weight gain during pregnancy: Reexamining the guidelines. Washington, DC: National Academy Press.

The IOM guidelines are meant to balance the need to prevent the delivery of a low-birth weight (LBW) infant (defined as weighing less than 2.5 kg at birth) against the risk of delivering a large-for-gestational-age (LGA) baby (defined as weighing more than 4.0 kg at birth). LBW is the largest and most consistent predictor of perinatal mortality in the United States (Harper & Wiener, 1965; McCormick, 1985). Historically, the clinical priority has been to ensure that women gained at least the minimum amount of recommended weight gain with little appreciation of the risks of gaining beyond the upper limit of the IOM guidelines. However, accumulating evidence has found high rates of short and long-term morbidities in women who gain above the upper limit recommended by the IOM (Amorim et al., 2007; Fortner et al., 2009; Hedderson et al., 2010; Linne & Neovius, 2006; Mamun et al., 2010; Rooney & Schauberger, 2002; Siega-Riz et al., 2009; Vesco et al., 2009; Walker, Fowles, & Sterling, 2011). Therefore, at the time the IOM revised their guidelines in 2009, the IOM called for a wider investigation of the impact of prenatal weight beyond its impact on birth weight including other outcomes such as breastfeeding initiation and duration, postpartum weight retention, and the development of obesity or

cardiovascular diseases in mothers and infants (Institute of Medicine & National Research Council, 2009).

The 2009 IOM guidelines incorporated two major revisions. First, the BMI categories were revised to match those used by the World Health Organization (Metropolitan Life Insurance tables were used as the standard in the 1990 version). Second, they specified a recommended weight range for the first time for obese women. The original 1990 guidelines only specified that obese women should gain a minimum of 15 lbs; no upper limit was specified. Up until the 2009 guidelines were revised, it was not possible to determine whether obese women gained a ‘healthy’ amount of weight since there was no agreed-upon allowable weight range set for obese women.

Conceptual Model

The Pregnancy Weight Gain Model (Figure 1) depicts the hypothesized interrelationships between the key variables in this study. This model is based on a review of the literature discussed in detail in Chapter 2. Pregnancy prompts food cravings in many women, although little is known about who is most likely to experience cravings. Risk factors, in particular smoking, being overweight or obese, or experiencing higher levels of stress or depression, may be associated with greater numbers and persistence of cravings.

Cravings are hypothesized to be associated with greater intake of craved food items. Women commonly report having multiple cravings, particularly for sweets, dairy products, protein, and carbohydrates (Crystal, Bowen, & Bernstein, 1999; Hook, 1978; Pope et al., 1992; Tepper & Seldner, 1999). Greater intakes of these foods are associated with greater prenatal weight gain in pregnancy (Olafsdottir et al., 2006; Uusitalo et al., 2009). Since many craved food items are calorie-dense, greater intake of craved food items, may be associated with greater prenatal weight gain. In addition, cravings wane for most pregnant women in the last few months of pregnancy (Belzer et al., 2010; Tierson et al., 1985). Women whose cravings persist into the third trimester are hypothesized to have higher dietary intake and prenatal weight gain than women who do not experience cravings throughout pregnancy.



Figure 1. Pregnancy Weight Gain Model

Purpose of the Study

The purpose of this retrospective chart review study was to describe the frequency of cravings in pregnancy, to describe the associations between cravings and prenatal weight gain, and to determine what factors were predictive of women reporting a greater number of cravings in pregnancy. This dissertation study used a retrospective design. Data were taken from existing medical records of women who received prenatal care in an urban community health center to address the following research questions.

Research Questions

The research questions addressed the frequency of cravings in pregnancy, the associations between cravings and prenatal weight gain, and the relationships between predictors of cravings and the numbers of cravings reported by women in pregnancy.

Frequency of Cravings

Research Question 1 “What is the Frequency of Craving in Early or Late Pregnancy?”

Research Question 1 described the frequency of cravings reported in early or late pregnancy. This analysis was designed to determine how common cravings were in general in pregnancy and if certain types of cravings were more common than others. Some cravings, such as sweet cravings, were hypothesized to be more problematic than others because they could result in women increasing their consumption of highly caloric food items. Therefore, it was important to understand not only how frequently cravings occurred, but also to determine the frequency of cravings for certain types of foods.

The analysis of this question was conducted using two variables, ‘cravings of any type’ and ‘cravings within food groups’, as determined by the responses on surveys women completed in pregnancy. The Maternal Wellness Survey (MWS) was completed twice in pregnancy, once at entry to

care and again in late pregnancy. The MWS lists six possible food groups within which women may be experiencing cravings: sweets, salty food, starchy food, fruit/vegetables, protein, and other. A woman was considered to have ‘cravings of any type’ if she checked off at least one of these food groups. Cravings within food groups were determined by which specific food group(s) a woman checked off on the MWS.

Research Question 2 “What is the Frequency of Reporting Cravings Throughout Pregnancy?”

Research Question 2 described the frequency of cravings across time during pregnancy as opposed to the cross-sectional analysis used in Research Question 1. This analysis described the ‘dose’ of cravings. Women reporting cravings in both early and late pregnancy were considered to have the highest dose. Persistent cravings across pregnancy were theorized to prompt sustained increases in dietary intake and therefore would be associated with greater weight gain, relative to women with transient or no cravings. Like Research Question 1, the analysis for this question was conducted using two variables: ‘cravings of any type’ and ‘cravings within food groups’ as determined by how women completed item-3 on the MWS in early and late pregnancy. Frequencies of reporting ‘cravings of any type’ and ‘within food groups’ was reported in four time periods: (1) never, (2) early pregnancy only, (3) late pregnancy only, and (4) in both early and late pregnancy.

Dietary Cravings and Prenatal Weight Gain

If cravings prompt women to eat more in pregnancy, they may gain more weight in pregnancy. Cravings appear to fade for many women as the pregnancy progresses. Therefore, women whose cravings persist throughout pregnancy were hypothesized to gain more weight than women with transient or no cravings.

Research Question 3 “Are Cravings Associated with Prenatal Weight Gain?”

The analysis for this question tested whether there were differences in prenatal weight gain between women who were categorized in Research Question 2 as having cravings in one of four groups: (1) never had cravings, (2) cravings in early pregnancy only, (3) craving in late pregnancy only, and (4)

cravings in both early and late pregnancy. This analysis was conducted using two variables: ‘cravings of any type’ and ‘cravings within food groups’, as described above.

Predictors of Cravings

Some women may be more likely to experience cravings. Non-pregnant women who are obese, who are experiencing depression and stress, or who smoke have been reported in the literature to experience more cravings than women without those risk factors (Burton et al., 2007; Franken & Muris, 2005; Pepino et al., 2009). Questions 4 explored whether these risk factors were predictive of the numbers of cravings women reported in pregnancy.

Research Question 4 “What Factors are Predictive of Reporting a Greater Number of Cravings in Pregnancy?”

Factors hypothesized to be related to women reporting a great number of cravings include BMI, symptoms of stress or depression, clinical depression, smoking status (smoker vs. nonsmoker), and for women who smoked, a reduction in the number of cigarettes smoked in pregnancy. The analysis of this question was conducted based on data taken from the clinical record and from data taken from the MWS completed by women in early and late pregnancy. The numbers of cravings women reported in pregnancy was based on the sum of the numbers of cravings women checked off on the two MWSs.

Definition of Terms

Definitions of the key concepts included in this study are described in the following section. An in-depth review of the literature related to these concepts is discussed in Chapter 2. Chapter 3 describes in detail how these concepts will be operationally defined in this study.

Risk Factors

Obesity. The determination of an individual’s BMI was based on the formula (kg/m^2), which incorporated an individual’s height and weight, to create a standardized measurement of fat deposition. BMI calculations allowed individuals of different statures to be compared with each other and was used to create categories of healthy and unhealthy weight (Institute of Medicine & National Research Council,

2009). A woman's BMI was categorized into one of four groups (underweight, normal, overweight, or obese) to describe the sample.

Smoking. Smoking in this study was defined as engaging in the act of smoking cigarettes. Women were categorized as being either a non-smoker or smoker at entry to prenatal care. Prenatal weight gain is higher in women who reduce smoking (Adegboye, Rossner, Neovius, Lourenço, & Linné, 2010; Favaretto et al., 2007). Therefore, the amount of cigarettes consumed by current smokers was described by the percentage decrease in the numbers of cigarettes women smoked from before pregnancy to during pregnancy.

Stress. Stress was defined according to how events or situations were perceived by the affected individual. Stress occurs when an individual perceives that he or she is facing an event or situation which strains or exceeds his or her resources to effectively cope with the demands generated by this event or situation. What is stressful to one individual may not be to another. Stress arises from judgments about the significance of the event or situation and whether it is dangerous or threatening (Glanz & Schwartz, 2008). In this study, the definition of stress was based on a woman's perception of her ability or inability to manage her stress.

Depressive Symptoms. Depressive symptoms were defined as feeling of sadness and lack of enjoyment in life. At least one of these two elements must be present to meet the diagnostic criteria for depression as set by the DSM-5 (Arroll, Khin, & Kerse, 2003; Uher, Payne, Pavlova, & Perlis, 2014).

Clinical Depression. Clinical depression is present when feelings of sadness or lack of enjoyment in life are so extreme as to precipitate somatic symptoms such as changes in sleep and appetite and poor concentration. To meet the criteria for depression, these symptoms must be severe enough to interfere with daily functioning and be present for a minimum of two weeks (Kroenke, Spitzer, Williams, & Löwe, 2010; Matthey & Ross-Hamid, 2011; Uher et al., 2014).

Cravings. Researchers who have addressed cravings in pregnancy to date have defined cravings as a strong desire to consume specific foods (Belzer et al., 2010; Crystal et al., 1999; Finely et al., 1985;

Luke, Keith, & Keith, 1997; Pope et al., 1992; Tepper & Seldner, 1999; Tierson et al., 1985; Worthington-Roberts, Little, Lambert, & Wu, 1989). This is the definition used in this study and is how the concept is defined by the general public .

Prenatal Weight Gain. Weight gain was defined as the change in body weight from early to late pregnancy. Healthy weight gain in pregnancy was determined using the criteria set by the IOM 2009 guidelines. These criteria are outlined in Table 1.

Weight-Gain Ratio. Forty percent or more of normal weight women and 60% or more of overweight women gain more than recommended by the IOM in observational cohort studies (Chu, Callaghan, Bish, & D'Angelo, 2009; Johnson et al., 2013). Since prevalence rates are high already, cravings are not likely to increase the prevalence of exceeding IOM recommendations. Rather, if cravings are related to greater weight gain, they are likely to be associated with a worsening of excessive prenatal weight gain. The prenatal weight-gain ratio is a measure that can detect incremental increases in weight above the recommended upper limit of the ranges set by the IOM. The prenatal weight-gain ratio is equal to one if a woman gains exactly at the upper limit of the allowable weight range set by the IOM for her BMI. While the upper limit of the allowable weight gain differs for underweight, normal weight, overweight, and obese women, values above one on the weight-gain ratio indicate the degree to which a woman over gains irrespective of her baseline BMI. Values of less than one indicate that a woman has either met or gained less than the IOM recommendation. Consequently, the prenatal weight-gain ratio can detect the entire range of weight gain possibilities from gaining less than to more than the IOM weight gain recommendations.

Importance to Nursing

Pregnancy is a time of transitions. Helping individuals through transitions has long been viewed by nursing scholars as an integral part of nursing practice (Kralik, Visentin, & van Loon, 2006).

Understanding the relationship between cravings and weight gain in pregnancy may provide a foundation for more effective nursing care of women at risk for weight-related perinatal complications. Learning

whether cravings are an expression of a healthy pregnancy or are more problematic in certain subgroups of women will mean that nurses can provide improved evidence-based care for women during their childbearing years. Nurses are on the frontline in provision of maternity care and are a trusted source of information and support for many pregnant women. Further nurse-midwives, have been instrumental in the development and dissemination of exemplary maternity care practices (American College of Nurse-Midwives, 2012). Thus the results of this study can be used by the professionals in the best position to effect improvements in care that will impact the immediate health of mothers as well as the health of future generations.

Conclusion

Little is known about how cravings, which are a common experience in pregnancy, are related to prenatal weight gain. Interventions designed to help women adhere to weight gain guidelines are largely ineffective. If cravings are found to be related to weight gain in excess of recommended guidelines in this study, then testing strategies to help women manage cravings in pregnancy should be explored in future studies. Thus, this study will address a major gap in the literature.

CHAPTER 2 REVIEW OF THE LITERATURE

This chapter summarizes the literature on topics relevant to food cravings and prenatal weight gain. It is organized in the following sections: (1) excessive prenatal weight gain, its sequelae and the effectiveness of interventions designed to help women gain an appropriate amount of weight in pregnancy, (2) the physiology of appetite and cravings, (3) cravings in pregnancy, (4) prenatal weight gain, and (5) populations potentially at greater risk of experiencing cravings.

Excessive Prenatal Weight Gain

The health and well-being of women and infants is dependent in part on pregnant women gaining within the weight gain recommendations set by the IOM. This section will first discuss the clinical ramifications of gaining more weight than recommended in pregnancy and then discuss the effectiveness of the interventions designed to help women gain within IOM recommendations.

Clinical Sequelae

Gaining above IOM prenatal weight gain recommendations is associated with immediate perinatal complications and is a consistent predictor of postpartum weight retention (Gore, Brown, & West, 2003; Johnson et al., 2013; Rooney & Schauberger, 2002; Vesco et al., 2009; Walker et al., 2011). Cohort studies have reported that 6% to 10% (Walker et al., 2011), 25% (Olson, Strawderman, Hinton, & Pearson, 2003), and 52% (Gould Rothberg et al., 2011) of women retain ≥ 5 kg at one year postpartum. In longitudinal cohort studies, women who gain excessively in pregnancy remain heavier 10 to 15 years or more after birth (Amorim et al., 2007; Fraser et al., 2011; Mamun et al., 2010; Rooney & Schauberger, 2002). Amorim et al. (2007) found that after controlling for education, lactation, and short-term postpartum weight retention in women delivering full-term infants ($N = 483$), women who exceeded IOM recommendations were 1.81 kg/m^2 heavier than women who gained within IOM recommended guidelines 15 years after giving birth. After controlling for multiple confounders such as age, parity, smoking, and breastfeeding, a similar study by Fraser et al. (2011) in 1,397 women found that women who gained excessively in pregnancy were 2.90 kg/m^2 , 95% CI [2.27, 3.52], heavier than women adhering to IOM

weight gain recommendations 16 years after delivery. A meta-analysis of 12 studies following women for 21 years after birth confirmed these results (Mannan et al., 2013).

Failure to return to a healthy weight postpartum undermines the health of the mother and fetus in future pregnancies. After adjusting for age, race and ethnicity, place of birth, gestational diabetes, BMI, and time intervals between pregnancies, increases of as little as 1.0 to 1.9 kg/m² between pregnancies were associated with increased risk of GDM in the subsequent pregnancy (adjusted odds ratio (AOR) 1.71, 95% CI [1.42, 2.07]) in a retrospective cohort analysis of 22,351 women (Ehrlich, 2011). In an even larger study of Swedish women ($N=151,025$), Villamor and Cnattingius (2006) reported similar findings. After adjusting for age, years of education, year of birth, country of origin, and smoking, increases of 3 kg/m² between pregnancies were associated with increased risk of developing GDM, AOR 2.09, 95% CI [1.68, 2.61](Villamor & Cnattingius, 2006). Results of another large cohort study ($N = 232,272$) indicated that women who became obese between pregnancies had a three-fold higher risk of developing GDM in the second pregnancy, OR 3.1, 95% CI [2.8, 3.4] (Whiteman et al., 2011). Other researchers have reported similar results (Wallace¹, Bhattacharya, Campbell, & Horgan, 2014). Thus, the risk of developing gestational diabetes is at minimum two-fold higher in women whose weight increases between pregnancies by one to three kg/m².

Further, maternal weight gain between pregnancies increases the risk of developing preeclampsia in future pregnancies (Frederick, Rudra, Miller, Foster, & Williams, 2006; Getahun et al., 2007; Villamor & Cnattingius, 2006; Wallace¹ et al., 2014). Women who gained 5.0 kg to 9.9 kg between pregnancies had higher risks of preeclampsia (AOR 2.6, 95% [CI 1, 6.7]) compared to women with stable weight in a prospective cohort study ($N=1,644$) (Frederick, Williams, Sales, Martin, & Killien, 2008). Getahun et al. (2007) reported that the risk of developing preeclampsia increased in a dose-response manner if a woman of normal weight in the index pregnancy became overweight (OR 2.0, 95% [CI 1.7, 2.3]) or obese (OR 3.2, 95% CI [3.1-4.3]) at the start of the next pregnancy. Wallace et al. (2014) reported similar increased

odds of developing preeclampsia in future pregnancies in women whose weight increased by 3 kg/m² or more between consecutive pregnancies, 1.85, 95% CI [1.12, 3.04], in a large cohort study ($N = 12,740$).

Increasing weight between pregnancies with its accompanying higher risk of preeclampsia in subsequent pregnancies poses significant health risks of women. Preeclampsia is the third most common cause of maternal death in the United States and is associated with the development of hypertension later in life (Bellamy, Casas, Hingorani, & Williams, 2007; MacKay, Berg, & Atrash, 2001). Women with previous preeclampsia had increased risks of experiencing hypertension (relative risks (RR) 3.7, 95% CI [2.7, 5.05]); ischemic heart disease (RR 2.16, 95% CI [1.86, 2.52]); and stroke, (1.8, 95% CI [1.45, 2.77]) in a meta-analysis of studies conducted between 1960 and 2006 ($N = 3,488,160$ women) (Bellamy et al., 2007). Likewise, having GDM is associated with future diabetes (Kim, Newton, & Knopp, 2002; Kjos et al., 1995; Retnakaran et al., 2008). Twenty-one percent of women diagnosed with GDM developed frank diabetes ten years after birth in a prospective cohort study ($N = 406$) (Sivaraman, 2013).

While the evidence is more limited, excessive prenatal weight gain appears to also adversely affect the health of children. Infants born to mothers who gained more weight than recommended in pregnancy are more likely to have higher body fat, worse cardiovascular profiles, and to be heavier in childhood and as young adults (Catalano, Presley, Minium, & Hauguel-de Mouzon, 2009; Mamun et al., 2010; Mamun et al., 2009; Olson et al., 2009; Reynolds et al., 2010; Wrotniak, Shults, Butts, & Stettler, 2008). Higher prenatal weight gain was associated with an increased risk of childhood obesity in two meta-analyses (Nehring, Lehmann, & von Kries, 2013; Tie et al., 2014). In a meta-analysis of 12 studies, gaining more than recommended by the IOM was associated with a 30% higher likelihood of childhood obesity, OR 1.33, 95 % CI [1.18, 1.50] (Tie et al., 2014). Similar risks between excessive prenatal weight gain and childhood obesity (OR 1.38, 95% CI [1.21, 1.57]) were reported by Nehring et al. (2013) in a meta-analysis of seven observational studies. The evidence suggests that excessive prenatal weight gain may affect exposed children throughout their lives.

Interventions

Helping women gain an appropriate amount of weight in pregnancy is one health-care strategy that can prevent or minimize the risk of developing obesity in mothers and children. Yet, interventions designed to achieve this goal have been marginally effective. Six meta-analyses systematically evaluated research on interventions directed towards weight gain in pregnancy (Campbell, Johnson, Messina, Guillaume, & Goyder, 2011; Gardner et al., 2011; Hill, Skouteris, & Fuller-Tyszkiewicz, 2013; Ronnberg & Nilsson, 2010; I Streuling et al., 2011; Streuling et al., 2010). Results of four of the six meta-analyses showed that interventions were effective in reducing prenatal weight gain by -0.22 to -1.54 standardized mean differences (Gardner et al., 2011; Hill et al., 2013; I Streuling et al., 2011; Streuling et al., 2010). The fifth meta-analyses found that interventions were ineffective (Campbell et al., 2011) and the sixth reported that the evidence was of insufficient quality to make any judgment about the effectiveness of interventions (Ronnberg & Nilsson, 2010).

In total, the results of these studies suggest that interventions may reduce prenatal weight gain. However, the critical issue is not whether women gain less weight; rather it is to what extent interventions help women adhere to IOM weight gain recommendations. Skouteris et al. (2010) included ten studies designed to improve adherence to IOM prenatal weight gain guidelines in a systematic review of studies published in English between 2000 and 2010. Six of the ten studies reported reductions in prenatal weight gain, but only three reported improvements in adherence to IOM weight gain guidelines.

Even fewer studies have specifically addressed the prevention of excessive prenatal weight gain by BMI category. Because overweight and obese women are more likely to exceed the IOM prenatal weight gain guidelines than normal weight women, it is essential that studies report out on whether interventions differ in their effectiveness in preventing excessive prenatal weight gain in normal weight, overweight, or obese women. Table 2 describes the five studies that reported on whether interventions decreased the risk of gaining more than recommended by BMI category (Jeffries, Shub, Walker, Hiscock, & Permezel, 2009; Olson, Strawderman, & Reed, 2004; Phelan et al., 2011; Polley, Wing, & Sims, 2002; Ruiz et al.,

2013). Interventions in all five of these studies were associated with decreased rates of excessive weight gain in normal-weight women, but had the opposite effect in overweight or obese women in three studies (Phelan, et al. (2011); Jeffries (2009); Polley, et al. (2002). Obese and overweight women in the intervention arms of the studies conducted by Phelan, et al. (2011), Jeffries (2009), and Polley, et al. (2002) gained more weight, not less weight, than those enrolled in the control arms. The remaining two studies were effective only in subsets of women. Ruiz et al. (2013) reported that the intervention was effective in normal weight but not overweight or obese women. Olson, Strawderman, and Reed (2004) found that their intervention was effective only in lower-income women. In addition, rates of excessive prenatal weight gain were high even for normal weight women in the intervention arms of effective studies, ranging from a low of 9% to a high of 40%. Thus, interventions consistently help normal-weight women, to a limited degree, meet IOM weight gain guidelines, but not overweight or obese women.

Table 2

Impact of Intervention Trials on Excessive Weight Gain by BMI Category

Year Author	Design	N	Arms	Normal Weight		Overweight		Obese	
				>IOM	WGR, kg	>IOM	WGR, kg	>10M	WGR, kg
				%	M (SD)	%	M (SD)	%	M (SD)
2013 ^a Ruiz	RCT ^b	962	Int ^c	12.6	18.7 (2.9)	49.3 ^b	14.5 (2.7) ^b		
			Con	22.1	19.5 (3.0)	58.9 ^b	14.2 (2.7) ^b		
2011 ^d Phelan	RCT ^b	401	Int ^c	40.2	15.3 (4.4)	66.7 ^b	18.2 (4.8) ^b		
			Con	52.1	16.2 (4.6)	61.1 ^b	19.6 (5.5) ^b		
2009 ^d Jeffries	RCT	236	Int ^c	9.0	11.5 (3.9)	35.0	10.0 (3.6)	36.0	9.5 (5.2)
			Con	16.0	12.0 (3.8)	56.0	13.3 (3.5)	24.0	8.2 (3.1)
2004 ^d Olson	QE ^f	560	Int ^g	29.0	NG	44.0	ng	NA	
			Con	45.0	NG	72.0	ng	NA	
2002 ^d Polley	RCT ^b	121	Int ^h	33.0	23.6 (ng)	59.0 ^b	17.7 (ng) ^b		
			Con	58.0	19.1 (ng)	32.0 ^b	17.3 (ng) ^b		

Notes. N = sample size; >IOM = exceeded IOM recommendations; WGR = weight gain ratio; RCT = Randomized control trial; Int. = intervention; Con. = control; QE = quasi-experimental; ng = data not given.

^a IOM 2009 Guidelines; ^b Combined overweight and obese women into one group; ^c Significantly reduced excessive weight gain for normal weight women, but not for overweight or obese women; ^d IOM 1990 Guidelines; ^e Significantly reduced gestational weight gain for overweight women only; ^f Excluded obese women; ^g Significant differences only for subgroups, specifically low-income normal weight and overweight women. Weight gain not reported; ^h Significantly reduced excessive weight gain in normal weight women only, opposite trend (but not significant) seen in heavier women. No standard deviations reported for weight.

One of the reasons that interventions tested to date have been minimally effective, at best, is that they may have included ineffective strategies. In a study combining a systematic review of the literature with a meta-analysis, Gardner et al. (2011) reported that the most commonly used strategies in interventions addressing prenatal weight gain were self-monitoring, intensive counseling, performance feedback, and goal setting. The authors concluded that evidence is inconsistent about which strategies were most promising (Gardner et al., 2011). In a meta-analysis of 19 studies, Hill, Skouteris, and Fuller-Tszkiewicz (2013) came to the opposite conclusion and found that many of these same techniques were associated with more effective interventions. None of the interventions evaluated in these meta-analyses

specifically included techniques to help women manage food cravings (Gardner et al., 2011; Hill et al., 2013). Lack of clarity about which interventions work best is particularly problematic for overweight and obese women, who are at greatest risk of excessive prenatal weight gain and have benefited the least from the interventions studied thus far.

Summary

Women who gain weight beyond the upper limit of the recommended IOM prenatal weight gain ranges are more likely to develop obesity, hypertension, and diabetes than women who gain within the IOM guidelines. Because the interventions tested to date have been minimally effective, the impact of other key variables, such as cravings, need to be considered. The effectiveness of interventions is particularly poor among overweight and obese women. If cravings are found to impact prenatal weight gain, then developing strategies to reduce the impact of cravings will need to be designed and tested, particularly for women at greatest risk of excessive prenatal weight gain.

Physiology of Appetite and Cravings

Cravings are a common feature of pregnancy, yet little is known about the physiologic changes in appetite regulation during pregnancy that results in an increase in cravings. Appetite regulation is accomplished through a complex interplay between the reward center of the brain, which impacts the perceptions of pleasure or displeasure associated with eating, and homeostatic processes, which balance energy intake and expenditure and result in stable weight. In non-pregnant women, food cravings are more likely to be related to the reward center of the brain than to homeostatic processes. But in pregnancy, increased hunger can be precipitated by the increased caloric needs in pregnancy and may be interpreted as cravings by some women. Dietary intake, and ultimately weight, is influenced by the interrelationships between the processes composing the homeostatic and hedonistic pathways.

Appetite Regulation

Most individuals maintain a stable body weight despite significant fluctuations in day-to-day energy intake and expenditures. Stable weight is a result of the interactions between peripherally released

hormones, gastrointestinal peptides, and inputs regulated centrally primarily by the hypothalamus (Neary, Goldstone, & Bloom, 2004). The most salient elements in these homeostatic processes in pregnancy are insulin and leptin (peripherally released hormones), ghrelin and cholecystokinin (gastrointestinal peptides), and a number of centrally-released neuropeptides, in particular neuropeptide Y (NPY), melatonin-concentrating hormone (MCH), agouti-related protein (AgRP), corticotrophin-releasing factor (CRF), cocaine- and amphetamine-regulated transcript (CART), alpha-melanocortin-stimulating hormone (α -MSH), and serotonin.

Each of these substances either enhances or suppresses appetite. Leptin is synthesized in adipose tissue and works centrally to reduce food intake; its actions are mediated through the hypothalamus. Levels increase in humans after several days of overeating and fall with fasting; these fluctuations are out of proportion to an individual's fat mass. Thus leptin is thought to affect weight stability even before weight gain has occurred by triggering a reduction in food intake and an increase in metabolic rate (Klok, Jakobsdottir, & Drent, 2007; Neary et al., 2004). Ghrelin is synthesized primarily in the stomach; one of its effects is to increase food intake. It is thought to signal pre-meal hunger and meal initiation (Neary et al., 2004). Higher pre-meal plasma ghrelin levels correlate with higher hunger scores in humans (Klok et al., 2007; Stanley, Wynne, McGowan, & Bloom, 2005). Cholecystokinin is thought to play a role in the cessation of eating through its impact on perceptions of satiety (Klok et al., 2007; Neary et al., 2004; Stanley et al., 2005).

In addition, centrally released neuropeptides, such as NPY, melatonin-concentrating hormone (MCH), and agouti-related protein (AgRP), stimulate the appetite, whereas others, such as corticotrophin-releasing factor (CRF), cocaine- and amphetamine-regulated transcript (CART), alpha-melanocortin-stimulating hormone (α -MSH), and serotonin, suppress it (Stanley et al., 2005; Williams et al., 2001). Release of the neuropeptides is affected by the gastrointestinal peptides and peripherally-released hormones. For example, NPY release is stimulated by ghrelin, one of the gastrointestinal peptides. CART release is stimulated by leptin, insulin, and glucocorticoids and results in diminished appetite (Leibowitz

& Wortley, 2004). Serotonin has a dual impact. It affects the reward circuitry of the brain through its connections between the brain stem and the hypothalamus (Neary et al., 2004; Stanley et al., 2005), but it also affects within-meal satiation and post-meal satiety by promoting the release of the agonist α -MSH, which results in diminished food intake (Joost, 2012).

Many of these neuropeptides are also components of the sympathetic nervous system and regulate mood and modulate the stress response, in addition to affecting appetite (Fulton, 2010). Ghrelin activates the reward center via the cholinergic-dopaminergic reward link, which is associated with greater motivation for and higher intakes of preferred foods (Joost, 2012). Elevated plasma levels of ghrelin have been associated with binge eating (Joost, 2012). In contrast, leptin is thought to dampen the reward response by suppressing dopamine release in the mesolimbic system (Joost, 2012). Cholecystokinin is thought to illicit a similar response. Insulin has a bidirectional response: at low levels it increases, and at higher levels it inhibits, dopamine release (Joost, 2012). Together these peptides affect the motivation aspect of reward prompted by dopamine, which is one of the key neuropeptides affecting the reward center (Fulton, 2010; Joost, 2012). The reward circuitry of the brain is involved with the formation of motivation, memory and habit, as well as the hedonistic evaluation of stimuli (Figlewicz & Benoit, 2009; Fulton, 2010).

Food cravings are thought to be strongly related to the reward circuitry of the brain (Hill, 2007). Higher sensitivity to reward is associated with overeating, particularly of high-fat sweet foods (Davis et al., 2007). It was also associated with obesity in a convenience sample of healthy pre-menopausal women ($N = 151$) (Davis et al., 2007). Davis et al (2007) used structural equation model to test the relationships between sensitivity to reward; overeating resulting from binge eating, external eating, and emotional eating; preferences for high-fat and high-sugar foods; and BMI. The proposed model was a good fit with the data. Sensitivity to reward was significantly correlated with overeating ($r = .57, p <.01$) and food preferences ($r = .41, p <.01$); in turn, overeating ($r = .32, p <.01$) and food preferences ($r = .18, p <.05$) were positively associated with higher BMI.

Emotional eating, which is associated with higher sensitivity to reward, is used by some individuals to manage feelings of stress, depression, or anxiety (Adam & Epel, 2007; Ouwens, van Strien, & van Leeuwe, 2009). Based on an extensive distillation of the literature, Macht (2008) developed a model describing the relationships between stress, appetite, and dietary intake. In this model, Macht (2008) postulates that high stress suppresses appetite and moderate stress will dampen or enhance appetite depending on an individual's cognitive and emotional relationship to food. Some individuals actively monitor their dietary intake; they are described as having dietary restraint. For individuals with high levels of dietary restraint, both positive and negative emotions can undermine the cognitive controls these individuals use to modulate their dietary intake. Less control results in increased intakes of food. Individuals with high levels of dietary restraint are more likely to binge when their cognitive controls lapse. Individuals who use food intake to manage negative emotions will increase their intake, particularly of sweets and fats, under stress (Macht, 2008). Individuals with healthier orientations towards food are relatively unaffected by stress (Macht, 2008).

In summary, appetite regulation is governed by a complex interplay between physiologic demands and emotional needs. The hypothalamus plays a key role. It integrates the messages received from the peripherally released hormones, endocrine hormones, gastrointestinal peptides, centrally released neuropeptides, and signals from the brain stem and reward center. Taken together, the hedonistic and homeostatic processes affecting appetite form a complex feedback loop, which for most non-pregnant individuals results in relative stability in weight.

Changes in Appetite Regulation in Pregnancy

However, changes in appetite must occur in pregnancy to allow the mother to gain enough weight to meet the demands of pregnancy and lactation. Although it is not clear how this occurs, the usual anorexic peptides are down-regulated early in pregnancy. There is an increased expression of NPY and AgRP, which stimulate appetite, and a decline in levels of α -MSH, which normally suppresses appetite. These changes prompt increases in food intake and weight gain (Grattan, Ladyman, & Augustine, 2007).

Leptin levels rise substantially in pregnancy due to its release from the placenta and accumulating maternal fat stores (Grattan et al., 2007; Tessier, Ferraro, & Gruslin, 2013). In non-pregnant women, high levels of leptin suppress appetite, but this does not occur in pregnancy. Thus pregnancy induces leptin-resistance (Grattan et al., 2007; Tessier et al., 2013).

In turn, leptin resistance is thought to contribute to the development of insulin resistance which is normal in pregnancy (Newbern & Freemark, 2011). Other hormones that likely contribute to the development of insulin resistance include placental growth hormone, progesterone, and glucocorticoids (Newbern & Freemark, 2011). Maternal insulin resistance blocks uptake of glucose into maternal cells, thereby increasing the availability of key nutrients to the fetus (Newbern & Freemark, 2011). Thus insulin resistance is an important adaptation that facilitates healthy fetal growth and development (Newbern & Freemark, 2011; Tessier et al., 2013).

Other changes in the hormonal milieu associated with pregnancy are thought to precipitate weight gain. Likely contributors are rising levels of progesterone, prolactin, oxytocin, and placental lactogen in pregnancy and the lack of cyclic changes in estradiol levels (Augustine, Ladyman, & Grattan, 2008; Douglas, Johnstone, & Leng, 2007; Grattan et al., 2007; Newbern & Freemark, 2011). Progesterone is associated with increased dietary intake even in the presence of high levels of leptin (Grattan et al., 2007). Estradiol inhibits food intake and increases leptin sensitivity; the relative decrease in estradiol compared to progesterone in pregnancy may attenuate this usual response (Augustine et al., 2008). Hyperprolactinemia, triggered by activation of prolactin receptors by maternal prolactin and placental lactogen, may also affect dietary intake (Newbern & Freemark, 2011). While not well understood, the changes induced by pregnancy in maternal and placental release of various hormones lead to an increase in hunger, dietary intake, weight gain, and a redistribution of critical nutrients to the fetus.

Physiologic Correlates of Cravings in Pregnancy

The physiology of cravings in pregnancy is unknown. Pregnancy induces both leptin and insulin resistance; these hormones affect appetite and modulate the reward circuitry in women who are not

pregnant (Figlewicz & Benoit, 2009). Because leptin and insulin levels increase substantially in pregnancy, it may be that higher levels of these hormones affect appetite and enhance cravings. However, only two studies have studied physiologic correlates of pregnancy cravings. These studies have been confined to women with and without GDM. These studies tested the theory that women with cravings will have more disordered glucose metabolism as measured by higher serum glucose, leptin, and insulin levels. Cravings in these two studies were measured by ‘liking scores’.

The two critical aspects of food reward are ‘wanting’ and ‘liking’ (Joost, 2012). Wanting in the context of reward does not refer to cognitively-based desire; rather it refers to conditioned associations with reward (incentive salience). Wanting can be unconscious and prompted by cues such as cooking smells or food packaging (Joost, 2012). Stimuli that have incentive salience hold more appeal and prompt greater effort on the part of the individual to obtain the desired stimuli. ‘Liking’ refers to the hedonic impact of a stimuli. In studies of reward, ‘wanting’ is usually measured by the amount of effort that is expended to obtain the reward, whereas ‘liking’ is measured by subjective evaluation of the degree of pleasure a stimuli imparts (Joost, 2012). Food cravings encompass both of these concepts; foods that are highly palatable are craved (liked) and may prompt extra effort on the part of the individual to obtain their desired food (wanted).

Tepper & Seldner (1999) compared changes across time in taste as measured by flavor intensity and palatability using ‘liking scores’ in non-pregnant women ($n = 12$), pregnant women without GDM ($n = 30$), and pregnant women with GDM ($n = 25$). Women participated in taste tests using sweetened milk samples and glucose solutions twice between 28 and 32 weeks of pregnancy and then again at 12 weeks postpartum. Women with GDM liked sweetened milk equally well during and after pregnancy, whereas women without GDM liked sweetened milk samples more postpartum than during pregnancy (Tepper & Seldner, 1999). In addition, after a 50-g glucose load, blood glucose levels were positively correlated ($r = .64, p < .001$) with higher liking scores for glucose solutions in women with GDM; this pattern was not evident in women without GDM. Higher liking scores were also correlated with higher intakes of fruit

and fruit juice in women with GDM, ($r = 0.45, p < 0.02$), but not in women without GDM (Tepper & Seldner, 1999).

In a prospective cohort study, Belzer et al. (2009) reported on the relationships between changes in taste, fasting glucose, insulin, and leptin levels in women with and without GDM ($n = 15, n = 93$ respectively) and in a non-pregnant control group ($n = 19$). All pregnant women showed higher liking scores as sweetness increased, but the pattern of liking differed between women with and without GDM. Women with GDM liked milk samples with higher concentrations of sucrose more than pregnant women with healthy glucose levels. Among women with GDM, there were significant positive correlations between higher liking scores and higher levels of fasting leptin ($r = .42, p = .017$) and insulin ($r = .63, p = 0.004$) (Belzer, Smulian, Lu, & Tepper, 2009).

Summary

Profound changes in appetite occur in pregnancy. These changes are necessary to ensure the health and wellbeing of mother and child. Cravings, which occur in most pregnant women, may be a key adaptation to help ensure that the fetus receives critical nutrients. However, experiencing more cravings may be more common, and consequently more problematic, in some pregnant women. Since so many women report increases in stress in pregnancy (Woods, Melville, Guo, Fan, & Gavin, 2010), stress may undermine an individual's cognitive controls, trigger cravings, or prompt emotional eating in vulnerable pregnant women, resulting in excessive weight gain. Greater liking of sweets was correlated with higher serum levels of glucose, leptin, and insulin in studies comparing women with gestational diabetes to women with healthy glucose metabolism. Thus women with abnormal glucose metabolism or higher levels of stress and depression may compose high-risk groups who are more likely to be adversely affected by cravings.

Cravings

Little research has been conducted on the prevalence of cravings in pregnancy or on identifying subpopulations more likely to experience cravings. A systematic search of the literature used

predetermined terms (English, human, pregnancy, cravings, food preference, and taste) to search electronic databases (Pub Med, PsychInfo, Web of Science) and identified eight studies published between 1975 and 2014 that described the prevalence of cravings in U.S. women with healthy singleton pregnancies (Belzer et al., 2010; Crystal et al., 1999; Finely et al., 1985; Hook, 1978; Pope et al., 1992; Tepper & Seldner, 1999; Tierson et al., 1985; Worthington-Roberts et al., 1989). Two more articles were identified from the reference lists of the above eight articles that described cravings in British women (Dickens & Trethowan, 1971; Fairburn, Stein, & Jones, 1992). Articles addressing cravings in non-Western populations or for non-food items were excluded in this review.

All of the 10 identified studies described the prevalence of cravings or the types of food women craved (Belzer et al., 2010; Crystal et al., 1999; Dickens & Trethowan, 1971; Fairburn et al., 1992; Finely et al., 1985; Hook, 1978; Pope et al., 1992; Tepper & Seldner, 1999; Tierson et al., 1985; Worthington-Roberts et al., 1989). Six of the 10 articles investigated whether specific subpopulations were more likely to experience cravings (Belzer et al., 2010; Crystal et al., 1999; Dickens & Trethowan, 1971; Finely et al., 1985; Tepper & Seldner, 1999; Worthington-Roberts et al., 1989). Three articles described the relationships between cravings and dietary intake (Belzer et al., 2010; Pope et al., 1992; Tierson et al., 1985).

Two additional articles were identified that addressed cravings. These articles did not describe the prevalence of cravings, rather they focused on the relationships between cravings and prenatal weight gain (Allison et al., 2012; Hill & McCance, 2014).

Prevalence and Timing of Cravings

Cravings occur in the majority of women. Prevalence rates reported in the literature range from a low of 51% to a high of 93% (Belzer et al., 2010; Dickens & Trethowan, 1971; Finely et al., 1985; Pope et al., 1992; Tierson et al., 1985; Worthington-Roberts et al., 1989). In a retrospective cross-sectional study, British nulliparous women ($N = 100$) who were interviewed within a few days after birth reported craving on average 1.8 food items in their pregnancy (Dickens & Trethowan, 1971). Crystal, Bowen, and

Bernstein (1999) reported higher numbers of cravings. In this retrospective cross-sectional study ($N = 131$), pregnant women were interviewed in mid-pregnancy and asked to recall the numbers of cravings they experienced before and during their pregnancy. Women reported an increase in cravings from 2.60 ($SD = 0.3$) food items before pregnancy to 4.04 ($SD = 0.04$) food items during pregnancy (Crystal et al., 1999).

Similar findings are seen in prospective studies. Fairburn, Steins, and Jones (1992) interviewed British pregnant women ($N = 100$) twice in early to mid-pregnancy and again in the third trimester. Fifty-three percent of women experienced cravings, which began on average at 9.2 weeks (range 4 to 20 weeks) of pregnancy and lasted on average 10.3 weeks (range 1 to 27 weeks) (Fairburn et al., 1992). Tierson et al. (1985) interviewed women ($N = 400$) about the onset and duration of cravings for 70 food items at five time points in pregnancy (< 13, 16, 20, 30, and 38 weeks of pregnancy). The onset of cravings began for over 90% of these foods in the first or early second trimester (Tierson et al., 1985). The duration of cravings lasted more than ten weeks for 70% of the foods women reported craving.

Pope et al. (1992) interviewed adolescent women ($N = 97$) every two weeks in the third trimester of pregnancy and then again at one year postpartum. Eighty percent experienced at least one craving, 50% reported two or more cravings, and 10% reported five or more cravings. Cravings were reported by 41% of women by the 12 week of pregnancy and by 86% of women by the end of the second trimester. Nearly 80% of women reported that cravings persisted throughout pregnancy. Although the authors did not describe the prevalence of cravings that persisted after birth, Pope et al (1992) reported that some women continued to experience cravings at one year postpartum (Pope et al., 1992).

Worthington, Little, Lambert, and Wu (1989) analyzed the frequency of cravings in women who exclusively breastfed ($n = 220$) compared to those who bottle fed ($n = 243$) their infants in a postpartum cohort study. Women were interviewed within four weeks of birth, at three months, and at one year postpartum. Overall 93% of women reported experiencing cravings in pregnancy compared to 75% of women postpartum (Worthington-Roberts et al., 1989). The authors hypothesized that lactating women

would have greater numbers of cravings due to the physiologic demands of breastfeeding. Although no statistical significant differences were noted in the prevalence or numbers of cravings between groups, lactating women reported craving 3.7 food items in pregnancy and 2.5 food items at one year postpartum whereas women who bottle fed their infants reported craving 5.1 food items in pregnancy and 3.8 food items at one year postpartum (Worthington-Roberts et al., 1989).

In a prospective cohort study of pregnant women with GDM ($n = 15$) and without GDM ($n = 97$) and non-pregnant controls ($n = 19$), Belzer, Smulian, Lu, and Tepper (2010) obtained data on self-reported cravings and dietary intake at 16 to 20 weeks, 24 to 28 weeks, and 34 to 39 weeks of pregnancy and at 6 to 10 weeks after delivery. Belzer et al. (2010) found that cravings declined in women with and without GDM as the pregnancy progressed, cravings were experienced by 77.8% of women with GDM and 81.0% of healthy women at 16 to 20 weeks, then rates declined to 60% and 57.4% in women with and without GDM, respectively, by 34 to 38 weeks gestation (Belzer et al., 2010). Cravings were relatively stable across time in non-pregnant women, affecting 50% to 69% of women in the control group. Cravings postpartum were experienced by 16.7% of women with GDM, 55.2% of women without GDM, and 50% of non-pregnant women in the control arm at 6 to 10 weeks postpartum (Belzer et al., 2010).

In total, these studies suggest that cravings are more common in pregnancy than before or after pregnancy. They affect the majority of pregnant women, generally beginning in the first half of pregnancy and fading to some degree in the last few months of pregnancy. However, the quality of the evidence addressing food cravings in pregnancy is poor. Many of these studies analyzed prevalence based on retrospectively recalled cravings; only three followed women prospectively from early to late pregnancy (Belzer et al., 2010; Fairburn et al., 1992; Tierson et al., 1985), making it difficult to understand what would be considered a normal craving pattern in pregnancy.

In animal research, pregnant mice increase their consumption of food in advance of significant changes in fetal mass. A similar pattern seems to occur in pregnant women in that cravings peak in early to mid-pregnancy before significant weight gain occurs (Belzer et al., 2010). For most pregnant women,

weight gain is minimal in the first trimester, greatest in mid-pregnancy, and slows in the third trimester (Institute of Medicine & National Research Council, 2009). If cravings prompt eating, then cravings should follow the same pattern: begin in early pregnancy, peak mid-pregnancy, and decline at the end of pregnancy. Having a better understanding of what would be considered a ‘normal’ number of cravings, when cravings are expected to occur, and how long they would be expected to last would make it possible to identify women who are experiencing ‘abnormal’ patterns of cravings that would be more likely to prompt excess dietary intake and result in excess prenatal weight gain.

Craved Foods

Cravings tend to be for foods within a woman’s usual repertoire (Finely et al., 1985). The most commonly reported craved food items include sweets (Belzer et al., 2010; Finely et al., 1985; Hook, 1978; Tepper & Seldner, 1999; Tierson et al., 1985), fruits and fruit juice (Belzer et al., 2010; Finely et al., 1985; Hook, 1978; Tepper & Seldner, 1999; Tierson et al., 1985), milk (Finely et al., 1985; Tierson et al., 1985), carbohydrates (Hook, 1978; Tepper & Seldner, 1999), salty items (Tepper & Seldner, 1999), ice (Tepper & Seldner, 1999), seafood (Tepper & Seldner, 1999), and savory items (Belzer et al., 2010). The top three most commonly cited food cravings reported in the literature are listed in Table 3 by their ranking in individual studies.

Table 3

Most Commonly Reported Food Cravings by Ranking in Individual Studies

Ranking	Food items	Number of Studies	Source
1	Sweets	3	Pope 1992, Finley 1985, Hook 1975
	Chocolate	2	Tierson 1985, Fairburn 1992
	Fruit and fruit juices	1	Tepper 1999
2	Fruit/fruit juice/citrus fruit	3	Pope 1992, Fairburn 1992, Tierson 1985
	Dairy	2	Hook 1975, Finley 1985
	Desserts	1	Tepper 1999
3	Fruit	2	Hook 1975, Finley 1985
	Ice cream	1	Tierson 1985
	Carbohydrates	1	Tepper 1999
	Protein Main Dishes, Fish	1	Pope 1992, Finley 1985
	Savory foods	1	Fairburn 1992

Influence of Cravings on Dietary Intake

Only three studies were identified that directly addressed the relationships between pregnancy cravings and dietary intake. Tierson et al (1985) and Pope et al (1992) reported that cravings were positively associated with increased dietary intake whereas Belzer et al. (2010) found no relationships between cravings and consumption of food items. Details of these studies are discussed below.

In a prospective cohort study, Tierson, Olson, and Hook (1985) interviewed pregnant women ($N = 400$) regularly throughout pregnancy beginning in the first trimester. Dietary intake was measured using a 24-hour diet recall and a 7-day diet history. Food cravings were defined as 'strong likes'. The authors found that women who had cravings for milk ($n = 12$), eggs ($n = 9$), or fruit ($n = 68$) had significantly higher intakes of these items than women without cravings, $p < .05$. For women with these cravings, intake of milk nearly tripled from a woman's last menstrual period until 12 weeks of pregnancy, while the consumption of eggs and fruit doubled in the same time period. Cravings were associated with increased intake for 16 of the 18 food items that could be tracked over time (Tierson et al., 1985). Dietary intake of craved food items jumped most dramatically in the first trimester.

In a similar study of pregnant adolescent women ($N = 97$), Pope et al. (1992) interviewed young women aged 11 to 17 years every two weeks in the third trimester of pregnancy and then at one year

postpartum. Dietary intake was assessed with two 24-hour recalls and 2-day dietary records. Women were queried about the types, onset, and duration of cravings and their beliefs relative to dietary cravings. The definition of craving was not described by the authors. Expectations about cravings were not associated with the reported frequency or numbers of cravings experienced by women. Women with cravings for sweets had significantly higher intakes of sugar than those who did not crave sweets (148 g vs. 120 g, respectively; $F = 5.57$, $p = .02$) and of energy (2,922 kcal vs. 2,364 kcal, respectively; $F = 6.28$; $p = .01$). Women with cravings for salty snacks compared to those that did not have cravings for salty snacks had significantly higher intakes of fat (122 g vs. 96 g; $F = 6.28$; $p = .02$) and salt (4,267 mg vs. 3,405 mg; $F = 5.69$, $p = .02$). Cravings for fruit was associated with a non-significant trend towards higher consumption of vitamin C (115 mg in women with fruit cravings vs. 92 mg in women with no fruit cravings; $F = 2.98$; $p = .09$).

The third study by Beltzer et al. (2010) analyzed food cravings and dietary intake obtained at three time points in pregnancy (16 to 20 weeks, 24 to 28 weeks, and 34 to 39 weeks of pregnancy) in healthy pregnant women ($n = 93$), women with diet-controlled GDM ($n = 19$), and non-pregnant women ($n = 19$). Cravings were defined as ‘a strong desire to eat a specific food’. Women were asked to name their three strongest food cravings (defined as the frequency cravings occurred over the preceding week). Cravings for specific food items were grouped into sweets, salty, savory, starchy, non-sweet dairy, and ‘others’ categories. Because only sweet and savory cravings were common, data analysis was confined to those two groups of craving. Dietary intake was assessed using a food frequency instrument. No relationship was found between sweet cravings and dietary intake in pregnant or non-pregnant women. The authors did not report on the relationships between total cravings or savory cravings and dietary intake.

In summary, the research on the relationships between cravings and dietary intake in pregnancy is limited. The findings of the three studies are difficult to interpret as the studies were conducted in different populations and used different measures to describe cravings and dietary intake.

Relationship between Dietary Intake and Prenatal Weight Gain

Because so few studies have been conducted to date on the relationships between cravings and dietary intake, a review of the literature was done to see what is known about the intake of specific foods relative to weight gain. Many women appear to increase their intake of unhealthy food in pregnancy. Women enrolled in two prospective cohort studies (Olafsdottir et al., 2006; Olson & Strawderman, 2003) and three cross sectional studies (Clark & Ogden, 1999; Pick, Edwards, Moreau, & Ryan, 2005; Pope, Skinner, & Carruth, 1997) report increases in pregnancy in the consumption of sweets (Olafsdottir et al., 2006; Pope et al., 1997), milk (Finely et al., 1985; Olafsdottir et al., 2006; Pick et al., 2005; Pope et al., 1997), grains (George, Hanss-Nuss, Milani, & Freeland-Graves, 2005; Pope et al., 1997), fruit (George et al., 2005; Pick et al., 2005; Pope et al., 1997), vegetables (George et al., 2005; Pope et al., 1997), and protein (Finely et al., 1985; George et al., 2005). Higher intakes of some of these food items, such as protein (Lagiou et al., 2004; Uusitalo et al., 2009), animal fat (Lagiou et al., 2004), milk (Olafsdottir et al., 2006), and sweets (Olafsdottir et al., 2006; Uusitalo et al., 2009) are associated with excessive prenatal weight gain.

Conversely, lower intakes of healthy foods are also associated with greater weight gain (Shin, Bianchi, Chung, Weatherspoon, & Song, 2014). After adjusting for age, race/ethnicity, trimester of pregnancy, education, marital status, family poverty, supplement use, physical activity, and pre-pregnancy BMI, Shin et al (2014) reported that eating fewer vegetables than recommended was associated with a three-fold increase in exceeding the IOM weight gain recommendations, AOR 3.8, 95% CI [1.1, 13.2], $p = .03$, in a cross-sectional study of women who participated in 2005 NHANES ($N = 490$).

Not only are intakes of specific foods associated with excessive prenatal weight gain, but so are perceptions of an overall increase in dietary intakes in pregnancy. Of the women ($N = 622$) enrolled in a prospective cohort study of primarily White women in Upstate New York, 23% reported 'eating a lot more' in pregnancy. Women who 'ate a lot more' compared to those that 'ate a little more' were

significantly more likely to exceed IOM recommendations, AOR 2.35, 95% CI [1.2, 4.5](Olson & Strawderman, 2003). In a similar observational study ($N = 144$), women who perceived themselves as eating more in pregnancy were more likely to exceed weight gain recommendations, OR 3.14, 95% CI [1.18, 8.36] (Althuisen, van Poppel, Seidell, & van Mechelen, 2009).

Eating more in pregnancy, as well as consuming more sweets and drinking more milk, was also associated with greater weight gain in a prospective cohort study of healthy pregnant Icelandic women ($N = 495$). After adjusting for maternal age, length of pregnancy, and smoking, eating more in late pregnancy, but not early pregnancy, was associated with increased risk of excessive weight gain, AOR 2.04, 95% CI [1.17, 3.58]. Eating more sweets in early pregnancy was associated with the highest risk of gaining more weight than recommended, AOR 2.52, 95% CI 1.10, 5.77 (Olafsdottir et al., 2006).

Similar findings were reported by Uusitalo et al (2009) in a retrospective cohort study of Finnish women ($N = 3,360$), which showed that consumption of fast food ($r^2 = .116$) and bread ($r^2 = .114$) was positively correlated with higher gestational weight gains. Women whose diet fell in the highest quartile of the Fast Food Pattern and Traditional Bread Group Pattern gained 1.3 kg and 0.9 kg more, respectively, over the course of pregnancy than those in the lowest quartiles (Uusitalo et al., 2009).

Streuling et al (2011) identified 12 observational studies addressing the relationships between dietary intake and prenatal weight gain. The authors were unable to create a summary statistic given the disparate definitions of dietary intake and prenatal weight gain used in the studies included in the review. However, the authors concluded that the evidence suggests that greater intake of protein, dairy, and energy is positively associated with higher prenatal weight gain (Streuling, Beyerlein, Rosenfeld, Schukat, & von Kries, 2011).

Summary

Cravings affect almost all pregnant women. Cravings are associated with increased intake in two of the three studies addressing the relationships between cravings and dietary intake. Many of the food items reported to be craved in the literature are the same food items that are associated with higher

weight gain. Cravings for sweets, dairy, and protein are among the top three most commonly reported craved foods; all are associated with higher prenatal weight gain (Lagiou et al., 2004; Olafsdottir et al., 2006; Uusitalo et al., 2009). These studies suggest that cravings could increase dietary intake and impact weight gain.

Prenatal Weight Gain

This section will discuss what is known about the relationships between dietary cravings and prenatal weight gain, as well as characteristics of women that are associated with prenatal weight. The most important of these characteristics are age, parity, and BMI. These three factors affect prenatal weight gain and should be considered for inclusion as confounding variables in any analysis involving prenatal weight gain.

Cravings and Prenatal Weight Gain

Only two studies describing the associations between dietary cravings and prenatal weight gain have been conducted. Both concluded that cravings were associated with higher prenatal weight gain (Allison et al., 2012; Hill & McCance, 2014). Only one of these two studies has been published in a peer-reviewed journal (Allison et al., 2012); the other is as of now only available as an abstract published online (Hill & McCance, 2014). Both of these studies are described in detail below.

In a study on the relationship between psychosocial factors and prenatal weight gain in overweight and obese African American women ($N = 120$), Allison et al. (2012) asked women to complete a questionnaire packet in mid-pregnancy between 14 and 24 weeks of pregnancy and then tracked their weight until the end of the pregnancy. Women were queried about symptomatology suggestive of eating disorders and depression, amount of sleep they got each night, and about their dietary behaviors (Allison et al., 2012). The instrument packet included several questions on food behaviors thought to be potentially related to weight gain: overeating at meals, snacking between meals or after dinner, eating due to physical hunger, eating due to cravings, and eating when anxious, bored, stressed, depressed, or alone. Women were asked to what extent these dietary behaviors influenced their weight

gain on a Likert scale from 1 (contributes not at all) to 5 (contributes the greatest amount). Among all the psychosocial and dietary behavior variables, only the item 'eating foods because I crave them' was significantly correlated with gestational weight gain, $r = .21$, $p < .05$ (Allison et al., 2012). Stepwise backward regression analyses were conducted with prenatal weight gain as the dependent variable and the following independent variables entered into the model: cravings, age, gestational age, pre-pregnancy BMI, and education. Weight gain progressively increased as women endorsed greater influence of cravings on weight gain. A one unit increase on the 5-point Likert scale asking women about the degree to which cravings contributed to their prenatal weight gain was associated with an adjusted β of a 5.1 kg per unit increase in prenatal weight gain (Allison et al., 2012).

The second article on prenatal weight gain has not yet been published. An abstract from the HAPO Study Cooperative Research Group published on line indicates that dietary craving are associated with both unhealthy dietary intake and greater prenatal weight gain (Hill & McCance, 2014). HAPO is a five year, prospective observational study that has recruited over 25,000 pregnant women in ten countries (HAPO Study Cooperative Research Group, 2002). Dietary intake and information on cravings was collected at 29 weeks of pregnancy for women participating in the Belfast cohort of the HAPO study, $N = 1,639$. The frequency of cravings did not differ between women who were underweight or normal weight compared to those who were overweight, or obese before the pregnancy (Hill & McCance, 2014). Compared to women without cravings, women with food cravings had higher energy intake ($M = 9,721$ kj, $SD = 3,016$ vs. $M = 9,256$ kj, $SD = 2,786$, $p = .002$) and greater prenatal weight gain ($M = 9.55$ kg, $SD = 5.4$ vs. $M = 8.95$ kg, $SD = 5.4$, $p = .049$), respectively (Hill & McCance, 2014). Of note is that the weight gain associated with cravings is small. Women with cravings gained on average 1 kilogram more in weight than those without cravings. Details are needed on how dietary intake and cravings were measured and how confounding variables, in particular BMI, were accounted for before an assessment can be made on the quality of this study.

In summary, little research has yet been published on the contributions of cravings to prenatal weight gain. While two studies are suggestive of a relationship, more rigorous and better designed studies are needed. Allison et al. (2012) asked only one non-neutral question on cravings. It asked the extent to which cravings contributed to weight gain. A better question would have been to ask women whether they were experiencing cravings and if so, the strength of those cravings from mild to strong, without asking about contribution to weight gain. Too few details are available on the study by Hill et al. (2014) to evaluate its quality.

Factors Associated with Prenatal Weight Gain

Three factors influence prenatal weight gain: age, parity, and BMI. These factors are potential confounding variables and should be considered for inclusion in any analysis of prenatal weight gain.

Age and Parity. In an extensive review of the state of the science, the authors of the 2009 Institute of Medicine Report, *Weight Gain During Pregnancy: Reexamining the Guidelines*, concluded that the weight of the evidence suggests that adolescents gain more than older women in pregnancy and women over 35 years of age gain less weight. The IOM 2009 report did not address the relationship between parity and weight gain. This may be because parity has a positive correlation with age, (i.e., younger women are more likely to be nulliparous and older women have usually had more pregnancies than younger women). However, cohort studies have consistently reported that, compared to multiparous women, nulliparous women gain more in pregnancy (Chasan-Taber et al., 2008; Chu et al., 2009; Lan-Pidhainy, Nohr, & Rasmussen, 2013; Olson & Strawderman, 2003). For example, in a prospective cohort study of Hispanic women ($N = 770$) analyzing predictors of inadequate and excessive prenatal weight gain, Chasen-Taber et al., (2008) reported that the percentage of women exceeding IOM recommendations dropped as age increased. Rates of excessive prenatal weight gain were 34.5 % in women aged < 20 years, 31.2 % in women 20 to 24 years, 27.1 % in women 25 to 29 years, and 28.3% in women 30 to 39 years, $p < .001$. Similarly, nulliparous women gained more weight than multiparous women. Fifty-eight percent of primiparous women gained more weight than recommended compared to

38.9% of pregnant women with one older child and 32.6% of pregnant women with two or more older children, $p < .001$ (Chasan-Taber et al., 2008).

BMI. Being overweight or obese, which affects nearly 60% of all women between the ages of 20 and 39 years of age (Flegal, Carroll, Ogden, & Curtin, 2010), increases the likelihood of gaining too much weight in pregnancy (Krukowski, Bursac, McGehee, & Delia, 2013; Walker et al., 2009). Overweight women were 2.87 times (95% CI [2.11, 3.90]), and obese women 1.82 times (95% CI [1.38, 2.39]), more likely than normal-weight women to exceed the upper limit of the weight ranges recommended by the IOM in a case-control study of Hispanic women living along the New Mexico-Mexico border ($N=1,597$) (Walker et al., 2009). In an analysis of data taken from the Arkansas Pregnancy Risk Assessment Monitoring System ($N = 4,619$ African American and White women), Krukowski et al. (2013) reported that, regardless of race, overweight women were three times more likely and obese women four times more likely than normal weight women to gain more than recommended by the 2009 IOM guidelines (OR 3.21, 95% CI [2.64, 3.91] and OR 4.37, 95% CI [3.50, 5.46], respectively).

Summary

The evidence is too preliminary to determine if cravings are related to prenatal weight gain. Analyses of factors associated with prenatal weight gain should include age, parity, and BMI as potential confounding variables.

Populations at Risk of Experiencing Cravings

Because cravings are so common, it is likely they are a physiologic adaptation to help ensure that women consume a sufficient amount of calories in pregnancy. If this is so, cravings may only be problematic in subpopulations experiencing more persistent or numerous cravings. Minimal research has been conducted to date on identifying subpopulations at greater risk of experiencing cravings in pregnancy. Researchers have investigated the relationships between cravings in pregnancy and nausea and vomiting [one study, (Crystal et al., 1999)], diet [one study, vegetarians vs. non-vegetarians, (Finely et al., 1985)], lactation status, [one study (Worthington-Roberts et al., 1989)], gestational diabetes [two

studies, (Belzer et al., 2010; Tepper & Seldner, 1999), smoking [two studies, (Adegboye et al., 2010; Dickens & Trethowan, 1971)] and stress [one study, (Dickens & Trethowan, 1971)]. Of these subpopulations, women who smoke cigarettes or experience stress are pertinent to this study.

Smoking

This section will discuss what is known about the relationships between smoking and cravings in pregnant women and then what is known about smoking and cravings in non-pregnant individuals. It will conclude with a discussion about the relationship between smoking and prenatal weight gain.

Cravings and Pregnant Smokers. Food cravings have been reported to be related to smoking in pregnancy. Dickens et al. (1971) investigated the relationships between smoking and cravings/aversions in pregnancy in a cross-sectional study of pregnant British women ($N = 100$). Women who smoked before pregnancy were significantly more likely to experience cravings and/or aversions than non-smokers, $\chi^2 = 4.966$, $n = 1$, $p < 0.05$ (Dickens & Trethowan, 1971). However, the authors did not describe demographic or medical information such as age, parity, BMI, or the amount of cigarettes women smoked.

In a prospective study ($N = 1,573$) investigating the association between smoking and prenatal weight gain, Adegboye et al. (2010) found that food cravings differed by smoking status. Cravings (defined as present/not present) were more prevalent in former smokers (58.7%) compared to current smokers (53.6%) and never smokers (50.6%), although these differences did not reach statistical significance ($p = .08$) (Adegboye et al., 2010).

Based on these two studies, cigarette smoking may be a risk factor for experiencing cravings in pregnancy, although the quality and quantity of the research published to date is insufficient to make any conclusions.

Cravings and Non-Pregnant Smokers. Studies conducted in the general population suggest that smokers experience more food cravings than nonsmoker (Mahler & de Wit, 2010; Pepino et al., 2009).

Mahler and de Wit (2010) conducted laboratory assessments of cue-induced and deprivation-induced

cravings for cigarettes and food in the same individuals ($N=15$ adult smokers). Each individual was asked to return to the laboratory four times: (1) after refraining from smoking for 18 hours, (2) after refraining from eating for 18 hours, (3) after refraining from both eating and smoking for 18 hours, and (4) having eaten and smoked as desired without restriction. At each session, individuals were shown images of cigarette smoking and palatable foods. Individuals with greater cue-induced and abstinence-induced smoking cravings also had greater cue-induced and abstinence-induced food cravings ($r = .57, p < .05$) (Mahler & de Wit, 2010). The researchers concluded that the findings suggest that some individuals are highly sensitive to reward stimuli, regardless of type of reward.

Pepino, Finkbeiner, and Mennella (2009) assessed food cravings in women by smoking status (i.e., never smoked, former smoker, or current smoker) and BMI (i.e., normal weight, overweight, or obese) in a cohort of non-pregnant women ($N = 229$). Cravings were defined as an intense desire for a food that was difficult to ignore. Cravings were categorized into groups: high-fat, sweets, carbohydrates/starches, and fast-foods. Women were asked to complete questionnaires measuring anxiety, anger, and depression. Among smokers, there was a significant correlation between higher BMI and higher depression scores, $r = .33, p = .008$. Current smokers craved high-fat foods more than former or never smokers. Current smokers craved food in general, and specifically carbohydrates, more than never smokers (Pepino et al., 2009). Other cross-sectional studies have also reported significant positive correlations between cravings for cigarettes and food (Jenks & Higgs, 2011; Styn, Bovbjerg, Lipsky, & Erblich, 2013). In addition, the quality of dietary intake of pregnant smokers is lower than non-smokers (Duarte-Salles et al., 2010; Mathews, Yudkin, Smith, & Neil, 2000; Wen, Rissel, Simpson, Lee, & Baur, 2011)

Smoking and Prenatal Weight Gain. If food cravings are higher in pregnant smokers, then these women may gain weight if they act on their cravings. Research studies have reported that women who quit smoking in pregnancy gain more weight. For example, women enrolled in a prospective cohort study ($N = 1,573$) who quit smoking had twice the risk of exceeding IOM prenatal weight gain

recommendations compared to never-smokers after controlling for dietary patterns, exercise, alcohol consumption, and pre-pregnancy BMI, AOR 2.0, 95% [CI 1.4, 3.0], $p < .001$ (Adegboye et al., 2010). In this study by Adegboye (2010), current smokers gained the least amount of weight. Other researchers have reported similar patterns (Favaretto et al., 2007; Levine, Cheng, Cluss, Marcus, & Kalarchian, 2013; Rodrigues et al., 2010).

Women who reduce the numbers of cigarettes they smoke but still continue to smoke in pregnancy also gain more weight. In a cohort study of never-smokers ($n = 2,368$), ex-smokers ($n = 915$), and current smokers ($n = 717$), Favaretto et al. (2007) reported that smokers and ex-smokers gained 0.38 kg, 95% CI [0.07, 0.68], more for each unit of reduction in smoking (10 cigarettes) after adjusting for age, parity, BMI, and educational attainment. When comparing ex-smokers to current smokers, weight gain was 0.28 kg, 95% CI [0.09, 0.65], higher for ex-smokers and 0.44 kg, 95% CI [0.11, 0.98], higher for smokers for each reduction of 10 cigarettes.

Summary. Thus smokers may be vulnerable to experiencing greater numbers of cravings than never smokers. In addition, dietary quality is lower and cravings more common, particularly for higher caloric foods, in smokers compared to non-smokers.

Stress and Depression

This section will discuss what is known about the relationships between cravings and stress or depression in pregnant women and non-pregnant individuals. It will conclude with a discussion of what is known about the relationships between stress or depression and prenatal weight gain.

Cravings and Stress or Depression in Pregnant Women. To date, only one research study has investigated the relationship between cravings and stress in pregnancy. A retrospective cross-sectional study of postpartum British women ($N = 100$) found that women who responded to stress with a change in appetite experienced greater numbers of cravings than women in any of the other possible groups, i.e., women with neither cravings or aversions, women with only aversions, and women with both cravings and aversion ($\chi^2 = 8.039$, $n = 1$, $p < 0.005$) (Dickens & Trethowan, 1971). Cravings were defined as an

increase in desire for a particular food item. The definition of stress and appetite changes was not provided by the authors.

While food cravings and stress in pregnancy have received little attention, evidence suggests that stress negatively impacts the quality of a woman's diet in pregnancy. Higher stress has been found to be associated with poorer quality dietary intake (Fowles, Bryant, et al., 2011; Hurley, Caulfield, Sacco, Costigan, & Dipietro, 2005; Lobel et al., 2008). Hurley, Caulfield, Sacco, Costigan, and Dipietro (2005) analyzed measures of anxiety, social support, stress, depression, fatigue, and pregnancy hassles and uplifts in relationship to dietary intake in a cross-sectional study of healthy pregnant women ($N = 134$) between 24 and 32 weeks of pregnancy. Stress was positively correlated with higher intake of energy ($r = .22, p < .05$), fat ($r = .24, p < .01$), and protein ($r = .24, p < .01$) and anxiety was associated with increased intake of fats, sweets, and snacks ($r = .23, p < .01$) (Hurley et al., 2005).

Fowles, Murphey, and Ruiz (2011) analyzed measures of depression, emotional eating, and dietary intake in a small sample ($N = 18$) of women in the first trimester of pregnancy. Lower intake of folate was associated with eating in response to anger ($r = -.75, p = .001$) and anxiety ($r = -.51, p = .02$). Eating in response to anxiety was also associated with lower intakes of iron-rich foods ($r = -.53, p = .04$) (Fowles, Murphey, & Ruiz, 2011). Depression was positively associated with greater intake of calcium-rich foods ($r = .60, p = .02$).

In a larger follow-up cross-sectional study of women in the first trimester ($N = 118$), Fowles et al. (2011) analyzed the relationships between emotional distress, social support, and dietary habits to dietary quality. Emotional distress was measured as a composite score of depression and stress. An index of social support was created by combining the amount of social support provided by a women's partner and family. Dietary habits were defined by an instrument measuring unhealthy dietary patterns, such as skipping meals, snacking, and frequency of consuming fast foods. Dietary quality was determined by analyzing three 24-hour dietary recalls. Distress was positively correlated with unhealthy dietary habits

($r = .395, p < .01$) and negatively correlated with dietary quality ($r = -.293, p < .01$). Path analysis showed that distress was the strongest predictor of dietary quality of all the variables in the model with a combined direct and indirect effect of $\beta = -.30$.

In a longitudinal prospective cohort study of pregnant women ($N = 279$), Lobel et al. (2008) elicited information on stress, anxiety, obstetric risk, and health behaviors during three interviews conducted over the course of the pregnancy. Higher levels of stress was positively correlated with caffeine intake ($r = .16$) and unhealthy eating ($r = .29$) and negatively correlated with healthy eating ($r = -.14$) and use of prenatal vitamins ($r = -.19$), all $p < .05$).

In summary, only one study has been conducted to date on the relationships between cravings and stress in pregnancy. This study found that cravings were higher in women whose appetite changed in response to stress. Individuals whose eating habits are related to their emotional state have been found to increase their dietary intake compared to women with a more healthy orientation to food (Macht, 2008). Dietary quality of pregnant women is undermined by stress. Thus it is may be that stress provokes cravings for unhealthy foods. No research has yet been done evaluating the cognitive processes in pregnant women that impact food choice.

Cravings and Stress or Depression in Non-Pregnant Individuals. Cravings in the general population have been reported to be related to greater neurological sensitivity to reward (Franken & Muris, 2005). Individuals with heightened reward sensitivity may be prompted to eat more food than those with normal reward sensitivity. In a cross-sectional study of female college students ($N = 99$), Franken and Muris (2005) investigated the relationships between food cravings and sensitivity to reward. Participants completed questionnaires on their response to situations that may result in rewards such as money, sex, power, sensation, and willingness to avoid situations that may result in worry, punishment, or failure. Participants also completed questionnaires on cravings measuring such concepts as planning to consume foods, anticipating positive reinforcements or relief of negative mood states by consuming food, and responding to environmental cues by an increase in food cravings. Sensitivity to reward was

significantly positively correlated with BMI ($r = .31, p < .005$) and total food craving score ($r = .32, p < .005$). Food cravings were also positively correlated with BMI ($r = .24, p < .001$).

In addition to being related to food cravings and higher BMI, sensitivity to reward has also been found to be associated with unhealthy eating patterns (Davis et al., 2007). A cross-sectional study of healthy adult women ($N = 151$) found that sensitivity to reward was significantly correlated with overeating ($r = .57, p < .05$), and that overeating was significantly correlated with binge eating ($r = .60$), external eating ($r = .71$), and emotional eating ($r = .72$) (Davis et al., 2007). Emotional eating was also significantly correlated with depression in another similar cross-sectional study (Ouwens et al., 2009). Ouwens et al. (2009) used structural equation modeling to test the relationships between depression, impulse regulation, ability to identify feeling, and emotional and external eating in a cross-sectional study of women ($N = 549$). Depression was significantly associated directly with emotional eating ($r = .20, p < .01$). Depression was also indirectly related to emotional eating through two pathways: (1) impulsivity (depression to impulsivity, $r = .68$, to emotional eating, $r = .14$, both $p < .01$) and (2) the inability to identify feelings (depression to difficulty identifying feeling, $r = .60$, to emotional eating, $r = .14$, both $p < .01$).

Thus cravings can be indicative of a maladaptive response to stress, depression, or anxiety. Pregnancy is stressful for many women (Lundren & Wahlberg, 1999). In one large cross-sectional study of pregnant women ($N = 1,522$); 6% reported high stress, 78% reported low or moderate stress, and 16% reported no stress (Woods et al., 2010). In cross-sectional studies of the general population, between 4% and 55% of respondents report eating more under stress (Macht, 2008). If pregnant women respond similarly, the added stress associated with being pregnant may trigger cravings and overeating.

Stress or Depression and Prenatal Weight Gain. If experiencing depression or stress triggers food cravings, then prenatal weight gain should be higher in women under emotional distress compared to those with healthy mood. However, emotional distress (as measured by stress, eating in response to negative emotions, and anxiety) has consistently been found to be associated with unhealthy dietary

intake, but not prenatal weight gain. Studies examining the relationships between stress or depression and prenatal weight gain have reported mixed results. Chasan-Taber et al. (2008) examined the determinants of prenatal weight gain in a prospective cohort study of Hispanic women ($N = 770$). The authors investigated the relationships between socio-demographic factors, health behaviors, and stress on gaining less than or more than recommended by the IOM prenatal weight gain recommendations. Stress was measured by the 4-item Perceived Stress Scale and the Life Events Scale; neither measure was related to categorical measures of prenatal weight gain (i.e., gaining less than, meeting, or gaining more than IOM guidelines) (Chasan-Taber et al., 2008). Experiencing adverse life events was not significantly associated with adhering to IOM prenatal weight gain guidelines in a larger population based study of all pregnant women giving birth in Colorado between 2000 and 2002 ($N = 6,625$) (Wells, Schwalberg, Noonan, & Gabor, 2006). However, as the numbers of stressful events increased, there was a trend towards lower prenatal weight gain. Twenty-two percent of women experiencing no adverse life events gained less than is recommended by the IOM compared to 27.7% of women experiencing ≥ 3 adverse events. The risk of excessive prenatal weight gain also declined as the numbers of stressors increased, but this trend did not reach statistical significance, p for trend = .08.

Webb, Siega-Riz, and Dole (2009) investigated the relationships between prenatal weight gain and stress, depression, and other psychological factors in a prospective cohort study of pregnant women ($N = 1,605$) beginning in early pregnancy. Women were interviewed twice in pregnancy. Variables included in this study were psychosocial measures (stress, depression, anxiety, self-esteem, and locus of control), as well as smoking status, dietary intake, exercise, and prenatal weight gain. Greater stress levels were marginally associated with inadequate weight gain in unadjusted models. This result was attenuated after adjusting for BMI, exercise, and other confounding variables. However, women who reported high depressive symptoms at both interviews were significantly more likely to exceed IOM weight gain recommendations, $p < .05$ (Webb, Siega-Riz, & Dole, 2009). The most significant predictor of weight gain in this study was having a high baseline BMI.

In total, these studies suggest that negative emotions are related to poorer quality dietary intake. However, the relationships between stress, depression, and prenatal weight gain are unclear.

Summary. In summary, studies of non-pregnant women suggest that cravings are more likely to be experienced in women undergoing stress or depression. In turn, women with stress or depression are more likely to engage in emotional eating, to overeat, and to be overweight or obese. Emotional distress, whether measured by stress, anxiety, or depression, is associated with poorer dietary quality in pregnant women. Women who eat to manage their emotions experience more cravings and consume more food (Macht, 2008). Overweight and obese women are most likely to be affected by emotional eating and by excessive prenatal weight gain. The only study to date that included pregnant women also found that food cravings were more common in women reporting that stress affected their appetite. Therefore, women who are depressed or stressed in pregnancy might report experiencing more problematic cravings than women of healthier mood.

Obesity

This section will address the relationships between cravings, dietary intake, eating patterns, and weight in obese pregnant and non-pregnant women.

Obese Pregnant Women. Only one study has addressed cravings in obese women (Hill & McCance, 2014). In a brief abstract published on line by the Belfast cohort of Hyperglycaemic and Adverse Pregnancy Outcome study (HAPO), overweight ($n = 491$) and obese women ($n = 262$) had no more cravings than women who were underweight or of normal weight ($n = 886$) (Hill & McCance, 2014). No details of this study are yet available.

While little research has been conducted on the relationships between cravings and obesity in pregnancy, being obese is consistently associated with consuming a poorer quality diet in early and late pregnancy. In a cross sectional study analyzing the dietary quality of women in the first trimester of pregnancy ($N = 51$), BMI was inversely correlated with folate intake, $r = -.28$, $p = .04$ (Derbyshire, Davies, Costarelli, & Dettmar, 2006). In a similar analysis of a larger sample of women ($N = 1,777$) in the

first trimester of pregnancy, scores of dietary quality as measured by the Alternate Healthy Eating Index dropped as BMI increased (- 0.9 points per each 5 kg/m² increase in BMI, 95% CI [-1.3, -0.4]) (Rifas-Shiman, Rich-Edwards, Kleinman, Oken, & Gillman, 2009). In an analysis of the dietary intake of obese pregnant women compared to overweight and normal weight pregnant women in the last trimester of pregnancy ($N = 2,394$), obese women were the least likely to meet the recommended daily intakes of fruits and vegetables and had significantly lower overall dietary quality, as measured by the Diet Quality index for Pregnancy (Laraia, Bodnar, & Siega-Riz, 2007).

Obesity is one of the strongest predictors of prenatal weight gain reported in the literature (Institute of Medicine & National Research Council, 2009). Experiencing greater or more persistent cravings may be one reason that overweight and obese women are less able to adhere to weight gain guidelines in pregnancy. It is possible that cravings contribute to the high rates of excessive prenatal weight gain seen among overweight and obese women by triggering unhealthy or greater dietary intake.

Obese pregnant women may also be at risk of experiencing cravings for three reasons. First, obese pregnant women are more likely to experience greater levels of leptin and insulin resistance than normal weight pregnant women (Catalano, 2010). Higher levels of these hormones in women are correlated with higher 'liking scores' (Belzer et al., 2009; Tepper & Seldner, 1999). Further, food craving have been found to be correlated with higher blood insulin levels in non-pregnant obese individuals (Jastreboff et al., 2013). In a study of normal-weight ($n = 25$) and obese ($n = 25$) individuals, Jastreboff et al. (2013) drew fasting insulin and glucose levels and obtained MRI scans after subjects listened to an audio-tape of three personalized guided imagery scripts on favorite foods, stress, and relaxation. After exposure to stress and favorite food conditions, food cravings were positively correlated with higher insulin levels and activation of the corticolimbic-striatic regions of the brain in obese individuals, but not in those of healthy weight (Jastreboff et al., 2013). These regions of the brain are part of the reward system of the brain. Therefore, obese women may be physiologically programmed to experience greater cravings in pregnancy.

Second, obese women are more likely to be depressed (Carey et al., 2014; Kelly, Daniell, Dal Grande, & Taylor, 2011). In a meta-analysis of 16 longitudinal studies that had baseline measures of depression and a follow up measure of weight change or obesity, depressed individuals at baseline were 1.8 times more likely to experience weight gain or to develop obesity in the future (Blaine, 2008). Depressed individuals experience more cravings or stronger desires for certain foods than those with healthy moods (Christensen, 2007; Mercer & Holder, 1997; Reed, Levin, & Evans, 2008).

Lastly, obese women are more likely to eat in response to negative emotions (emotional eating) or environmental triggers (external eating) (Davis et al., 2007). Women who engage in these eating patterns or who actively refrain from eating certain foods to control their weight (restrained eaters) experience greater cravings (Hill, 2007; Macht, 2008; Ozier et al., 2008). Burton, Smit, Lightowlerl (2007) described patterns of cravings by gender in relationship to emotional, external, and restrained eating in a cross-sectional study of Dutch men and women ($N = 124$). For women, higher BMI was positively correlated with total cravings ($r = .20, p = 0.04$), cravings for fat ($r = .28, p = 0.01$), and cravings for fast food ($r = .21, p = 0.03$) (Burton et al., 2007). External eating was a significant predictor of total cravings and sweet cravings in women. Emotionality was a significant predictor of cravings for sweets and fats in women who were restrained eaters. In the final analysis, the authors concluded that cravings mediate the relationship between external eating and BMI.

Obese Non-Pregnant Women. Other researchers have also reported positive associations between emotional and external eating styles, overeating, and higher BMI in cross-sectional (Anschutz, Van Strien, Van De Ven, & Engels, 2009; Davis et al., 2007; Ouwens et al., 2009) and in longitudinal studies (Keski-Rahkonen et al., 2007) of the general population. Keski-Rahkonen et al. (2007) obtained data on personality, eating styles, and BMI in healthy twins ($N = 4,393$) at age 16 and then again between 22 and 27 years of age. Women were significantly more likely than men to engage in comfort eating, to use food as a reward, to eat in response to visual cues, to eat throughout the evening, and to snack frequently (all $p < .001$) (Keski-Rahkonen et al., 2007). After controlling for baseline BMI, many of these

patterns were significantly related to obesity in young adult women. Risk of obesity was higher in women who engaged in restrictive eating patterns (AOR 8.0, 95% CI [4.2, 15.3]), snacked between meals (AOR 2.7, 95% CI [1.6, 4.6]), ate when prompted by visual cues (AOR 4.4, 95% CI [1.3-14.1]), or ate for comfort (AOR 2.4, 95% CI [1.2, 5.0]). The risk was lower for women who attempted to eat healthy foods (AOR 0.2, 95% CI [0.1, 0.3]) or avoided highly-caloric foods (AOR 0.4, 95% CI [0.2, 0.6]).

In total, studies in non-pregnant obese individuals suggest that higher or more intense cravings are likely to be positively correlated with BMI. Too little research has been conducted in pregnant women to know if there is a relationship between cravings and obesity in pregnancy, but there is evidence that dietary quality is worse in obese women compared to women of healthy weight. Therefore, women who are overweight or obese at the beginning of their pregnancy may be at risk for experiencing greater numbers of cravings, particularly for high-caloric foods, than women of normal weight.

Summary. While cravings are a common feature in pregnancy, they may be more pronounced in certain women. They may be precipitated by the normal changes in appetite regulation that occur in pregnancy, but may also be reflective of already established pre-pregnancy patterns of behavior. Cravings are common in women who engage in less healthy patterns of eating, such as emotional, external, or restrained eating. Stress or depression can trigger emotional eating in some vulnerable women and undermine the ability of women to control their intake. Smokers often report cravings for food as well as cigarettes. Thus while cravings are a normal response to pregnancy, they may be more numerous or persistent in women who are overweight or obese before pregnancy, who experience stress or depression, or who are current or former cigarette smokers.

Conclusion

Few women follow the prenatal weight gain recommendations set by the IOM. Failure to do so is associated with significant immediate and long-term risk for the mother and affected infant. Cravings are common in pregnancy and may impact dietary intake, thereby influencing prenatal weight gain. Only three articles have been found that describe the relationships between cravings and dietary intake; two of

these studies, but not the third, found that cravings were related to higher consumption of craved foods. If women with cravings respond by eating in excess, then women who report dietary cravings may be at risk of gaining too much weight in pregnancy. Although the definitions of cravings vary, the authors of the only two studies addressing cravings and weight report higher prenatal weight gain in women with cravings as opposed to those without cravings.

Antecedent factors related to pregnancy such as cravings have received little attention in the research literature to date. However, there is some evidence that cravings are greater in women who smoke, are obese, or eat in response to stress. If relationships are found between cravings and prenatal weight gain, then interventions may need to be tailored to match the needs of particular at-risk women. Counseling on how to manage cravings may be helpful. Preliminary research suggests that techniques, such as mindful eating, acupuncture, and psychological interventions, help in the management of cravings in the general population. These same techniques may also be helpful in managing cravings in pregnant women (Alberts, Mulkens, Smeets, & Thewissen, 2010; Stapleton, Sheldon, Porter, & Whitty, 2011; Van Gucht, Baeyens, Vansteenwegen, Hermans, & Beckers, 2010). Therefore, understanding if cravings are related to prenatal weight gain, and if so who is most affected, may prompt the testing of other types of intervention than have been tested so far and ultimately lead to improvements in adherence to IOM weight gain guidelines

CHAPTER 3 METHODS

This chapter describes the methodology used in this study. The purpose of this retrospective chart review study was to describe the frequency of cravings in pregnancy, the associations between cravings and prenatal weight gain, and factors predictive of women reporting a greater number of cravings in pregnancy. Cravings were hypothesized to be associated with higher prenatal weight gain. Based on a review of the literature, cravings were also hypothesized to be more numerous in certain high-risk groups; specifically in women who smoked cigarettes (Dickens & Trethowan, 1971), who were overweight or obese at the start of pregnancy (Burton et al., 2007), or who experienced higher levels of stress and depression (Dickens & Trethowan, 1971; Ouwens et al., 2009).

Research Design

This study used a retrospective design. Existing medical records were reviewed to determine if subjects met eligibility criteria. Data needed to describe the sample and to answer the study questions were taken from the medical records of a convenience sample of women receiving care in an urban community health center between January 1, 2006 and December 31, 2012.

Setting

This study was conducted at an inner-city community health center serving residents of the Hunts Point and Mott Haven neighborhoods in the South Bronx. Residents of these neighborhoods are predominantly Hispanic (73%) and Black (24%), and nearly half live below the poverty level (Olson, Van Wyke, Kerker, Thorpe, & Frieden, 2006). The most commonly reported countries of affiliation for Hispanic individuals in these neighborhoods are Puerto Rico, Dominican Republic, and Mexico (NYC, 2013). One-third of women giving birth in these communities receive late or no prenatal care (Olson et al., 2006). The South Bronx infant mortality rate of 7.6% is higher than New York City as a whole (4.9%) (NYC department of City Planning). Two-thirds of adults are overweight or obese in the South Bronx (Matte et al., 2007). Of young adults ages 18 to 44 years, 19% are obese (Matte et al., 2007).

Sample

Subjects included in this study were drawn from a subset of the sample of women who received prenatal care at the SBHC between January 1, 2006 and December 31, 2012. This community health center provides prenatal care to residents of the surrounding communities of Hunts Point and Mott Haven. Nearly 60% of residents of these communities receive governmental cash supports through programs such as Medicaid and supplemental social security assistance (NYC department of City Planning). Residents of these communities also have high rates of smoking (20%), diabetes (17%), and depression (9%); all of these rates are higher than for NYC as a whole (Olson et al., 2006).

Sample Size

Determining the number of cases that should be included in a study depends on the research questions, the desired power, and anticipated effect size (Green, 1991). Tabachnik and Fidell (2007) recommend using the formula, $N \geq 50 + (8 \times \text{number of predictors})$, to determine the size of the sample needed to conduct regressions and using the formula, $N \geq 104 + \text{numbers of predictors}$, to determine the size of the sample needed to test for the contribution of individual predictors to the model. Both formulas assume a medium effect size, $\alpha = .05$, and $\beta = .80$ (Tabachnik & Fidell, 2007). Field (2009) suggests using these same formulas, but also suggests calculating the sample size with both formulas and then using whichever sample size is higher. In an extensive review of alternative methods of calculating sample sizes, Green (1991) concluded that these formulas resulted in appropriate sample sizes if medium effect sizes and standard power were desired, but suggested using more complex formulas if effect sizes were anticipated to be low.

Potential risk factors for cravings were (1) BMI, (2) smoking status (non-smoker or current smoker), (3) reduction in the numbers of cigarettes smoked for current smokers, (4) stress symptoms, (5) depressive symptoms, (6) clinical depression, and (7) maternal age. These risk factors were to be regressed on the dependent variable (total numbers of cravings in pregnancy). Assuming a medium effect size, standard power ($\alpha = .05$ and $\beta = .80$), and 7 independent variables, the above formulas suggested that

a minimum sample size of 106 was needed to conduct regressions and 111 was needed to test for predictors. Thus, a minimum sample size of 111 subjects is sufficient to address the research questions using multiple regressions.

Eligibility Criteria

Women with healthy singleton pregnancies who delivered a full-term infant were eligible to be included in the study. Women were ineligible if they were younger than age 18 or had gestational diabetes or other medical conditions requiring on-going supervision by the OB High-Risk Clinic. These factors can impact the type and intensity of prenatal care a woman might receive during pregnancy, which in turn could influence the amount of weight a woman gains in pregnancy. For example, women less than 18 years of age are still growing themselves and have different nutritional needs than older women. Women with gestational diabetes also need more support to maintain healthy blood glucose levels. Consequently, adolescent women and women with gestational diabetes receive intensive nutritional education in pregnancy, whereas few women in routine care are seen by a nutritionist. In addition, women receiving care at the OB High-Risk Clinic receive more intensive counseling in general and are seen more frequently than women in standard care. Further, some women with medical conditions may be on medications such as corticosteroids that can affect prenatal weight gain.

Women were also deemed ineligible for three other reasons: (1) they were pregnant with multiple fetuses, (2) had repeated pregnancies, or (3) were not proficient in English. First, greater prenatal weight gain is expected in women who are pregnant with multiple fetuses compared to women with singleton pregnancies, making it inappropriate to include women pregnant with multiple fetuses in the sample. Second, while some women had several pregnancies in the sampling period in this study, only one pregnancy was included in the analysis. Double counting women could bias the results. Lastly, women who did not complete an English version of the MWS were also excluded from the study. The Spanish language version was not tested for cultural equivalency in the population of Hispanic women receiving care at the community health center. Because the surrounding community is composed primarily of

Hispanic individuals affiliated with Puerto Rico, Dominican Republic, or Mexico, it is uncertain whether the translation was valid for each of these populations.

In summary, women were eligible if they had a healthy singleton full-term pregnancy. Women were ineligible if they were (1) less than 18 years of age, (2) had a medical condition requiring on-going supervision at the OB High-Risk Clinic, (3) had gestational diabetes, and (4) were non-English speakers. Only one pregnancy per woman was eligible to be included in the sample.

Sampling Plan

A convenience sample was drawn from the sample of women receiving care at the community health center from 2006 to 2012. Potentially eligible women were identified from the pregnancy tracking sheet. The pregnancy tracking sheet is a clinical log maintained by the OB service at the SBHC to facilitate follow up of pregnant women enrolled in care. The clinical tracking log includes the name and medical record number of women receiving prenatal care at the SBHC, the date of their first prenatal visit, and the date the baby is expected to deliver. Thus, a study tracking log of potentially eligible women was created from the pregnancy tracking sheet. The charts of women that were identified as being potentially eligible from the pregnancy tracking sheet were then reviewed to determine if they met the eligibility criteria, and, if so, data was taken from their medical records to answer the research questions.

Human Rights Protection

Study approval was obtained from the Human Subjects Protection Program at the University of Arizona and the Institutional Review Board of Montefiore Medical Center. Because this study was based on de-identified data obtained during routine care and taken from the medical record, it was of minimal risk to the woman included in the study. The researcher requested and received a waiver from informed consent.

Measures

Relevant data were taken from the medical record in order to determine eligibility, describe the sample, and to answer the research questions. The MWS is administered to prenatal women as part of

clinical care and is completed at the first prenatal visit (MWS T1) and again later in the last half of pregnancy (MWS T2). It is a four-page questionnaire given to patients by the front desk and nursing staff. It is used by clinicians to identify unhealthy behaviors, emotional problems, undue stress, or depression in pregnant women. Once completed, it is scanned into the medical record. The MWS contains items on self-reported cravings, depression, and stress, as well as other issues of clinical concern during pregnancy. The responses to three items on the MWS were relevant to the research questions. These included Item-3 on cravings, Item-6 on symptoms of stress, and Item-8 on symptoms of depression. These items are designated on the MWS found in Appendix A as Item-3 (I-3), Item 6 (I-6) and Item 8 (I-8). Responses to these items were used in the analyses of the research questions.

Of note is that the MWS changed over time. Three different versions were used since it was first introduced in 2006. All three versions included the same questions on cravings. The second version, introduced in approximately 2010, used the same questions on cravings, but added questions on stress and depression among other issues. The third version, launched in January 2012, used the same questions on cravings and stress as were used in earlier versions, but slightly modified the questions on depressive symptoms.

The following section describes the specific data that were collected in this study. It is organized into the following sections: demographics, risk factors for cravings (smoking, stress symptoms, depressive symptoms, and clinical depression), cravings, and prenatal weight gain.

Demographics

The following data were taken from the medical record: date of birth, parity, race, ethnicity, and language preference. Age was calculated in years from date of birth to entry into prenatal care. Parity was defined as the number of children a woman had given birth to over the course of her life. Parity was also defined as a categorical variable, nulliparous (pregnant with first child) and multiparous (currently pregnant and has one or more older children). Race and ethnicity were determined by the responses on the patient-completed registration form. Choices for race included White, African American, Asian,

American-Indian, Multi-Racial, Declined, and Other. Choices for ethnicity included being Hispanic with response options of yes, no, or declined to answer. Language preference was determined by whether a woman completed an English or Spanish version of the MWS. Women who completed a Spanish version of the MWS were ineligible for this study.

Risk Factors

Smoking. Data on smoking was taken from the medical record. Women were categorized as being a current smoker or a non-smoker depending on whether they were smoking at the onset of prenatal care. For smokers, the amount a woman smoked was described by the change in the numbers of cigarettes a woman smoked from before to during pregnancy. The percentage decrease in the numbers of cigarettes a woman smoked was calculated by dividing the lowest number of cigarettes a woman reported smoking during pregnancy by the numbers she reported smoking at the onset of prenatal care.

Stress symptoms. Short stress scales have been used to assess the associations between higher stress and unhealthy behaviors such as smoking, higher rates of obesity, and greater mortality in prospective cohort studies (Nielsen, Kristensen, Schnohr, & Grønbaek, 2008; Rod, Grønbaek, Schnohr, Prescott, & Kristensen, 2009). One item on the MWS asks about a woman's 'ability to handle stress' (Item 6, I-6). Scores range from 1 to 6, the higher the score the higher the stress level. This item was adapted from one of the items included in the Two-item Brief Stress Scale (Littman, White, Satia, Bowen, & Kristal, 2006). This question asks the respondent to rate their ability to handle stress from 1 (I don't let things bother me) to 6 (I get very stressed about things).

The validation study for this instrument compared the Two-Item Brief Stress Scale against a 53-item questionnaire on hassles (Hassles and Uplifts Scale), a four-item questionnaire on perceived stress (short version of the perceived stress scale), and a ten-item questionnaire on life events (Women's Health Initiative Life Events Questionnaire)(Littman, 2006). The two items in this scale asked an individual about his or her 'ability to handle stress' and 'amount of stress'. The authors designed the scale to be used either as a two-item scale or for each question to be used alone as a stand-alone item. Both

items were validated together as a scale, as well as separately. Adjusted correlations between the sum of the stress scale and the Perceived Stress Scale was 0.44, Life Events 0.31, and Hassles 0.46. Weighted Kappas for three month test-retest reliability for 'ability to handle stress' was 0.71, 95% CI [0.64, 0.77], and for 'amount of stress' was 0.66, 95% CI [0.65-0.79]. Age- and sex-adjusted Pearson correlations between 'ability to handle stress' and the Perceived Stress Scale was .37, .20 for Adverse Life Events, and .34 for Hassles (Littman et al., 2006). Of note is that these correlations were similar to or better than those correlations seen between the three comparison instruments. Thus, the two items, singly or together as a composite measure, perform as well or better than other similar, but longer validated instruments measuring stress.

Depressive Symptoms. Two items screen for depressive symptoms on the MWS (Item 8, I-8). These two items are the Patient Health Questionnaire (PHQ-2), a validated screen for depressive symptoms. The PHQ-2 asks whether an individual has been bothered by (1) feeling down, depressed, or hopeless or (2) little interest or pleasure in doing things (Arroll et al., 2003; Kroenke, Spitzer, & Williams, 2003). Different versions of the PHQ-2 are available. Some versions ask if symptoms have been present for two weeks or more, other versions ask about symptoms lasting for one month or more. Response options can also vary. Some versions use a simple response set of 'yes' or 'no' and others use a range of 'not at all' to 'nearly every day'. Two different versions of the PHQ-2 have been used on the MWS. The first asked about symptoms over the past month, the second over the last two weeks. Both versions used response options of 'yes' or 'no.'

In an extensive review of the literature, Kroenke, Spitzer, & William concluded that the use of abbreviated PHQ-2 questionnaires is as effective in detecting depression as other longer case-finding instruments reported in the literature. Variations in format (i.e., time frame and response categories) do not affect sensitivity or specificity (Kroenke et al., 2010); one study using the yes/no response on the frequency of symptoms over the last four weeks reported a sensitivity of 94% and specificity of 67%

(Arroll et al., 2003). A study using the frequency of symptoms over the last two weeks reported similar sensitivity and specificity results (Kroenke et al., 2003).

Further the PHQ-2 has been shown to have good psychometric properties when used with pregnant women. Bennet et al. (2008) compared the PHQ-2 against the Edinburgh Postnatal Depression Scale (EPDS), which is a widely used screening tool for perinatal depression. To determine the relative effectiveness of screening with the PHQ-2 and the EPDS, Bennett et al. (2008) screened women with both instruments at three time points (15 weeks of pregnancy, $n = 414$; 30 weeks of pregnancy, $n = 334$; and 6 to 16 weeks postpartum, $n = 193$). In this study, scores ≥ 13 on the EPDS were considered positive. When compared against EPDS scores of ≥ 13 , the PHQ-2 had a sensitivity and specificity of 93% and 75% respectively at 15 weeks of pregnancy, 82% and 80% respectively at 30 weeks of pregnancy, and 80% and 86% respectively postpartum (Bennett et al., 2008). Similar psychometric properties were found when comparing the results of the PHQ-2 against the PHQ-8 (which omits one question from the PHQ-9 on suicidal ideation), and a structured diagnostic interview in a cross-sectional study of pregnant women ($N = 218$) before the 17th week of pregnancy (Smith, Gotman, Lin, & Yonkers, 2010).

Scoring is based on whether an individual checks yes (scored as 1) or no (scored as 0) on one or both items. Results range from 0 to 2. A score of 1 or 2 is considered positive and prompts further evaluation with either a longer validated screen for depression, the Patient Health Questionnaire-9 (PHQ-9), or a clinical interview to diagnose depression.

Clinical Depression. A diagnosis of clinical depression was based on documentation in the chart on a woman's mental health status. It is standard practice to assess a woman's current and past history of mental illness in prenatal care. Clinicians determine if a woman has depression based on the results of a clinical interview or a validated instrument that mirrors the nine DSM diagnostic criteria for depression, such as the PHQ-9. Clinicians then document in the medical record their final assessment (whether a woman is currently depressed, had a prior history of depression and is in remission, has other mental health concerns, or has no depression) and note their assessment on the problem list.

Cravings. The MWS includes one item, item-3 (I-3), on dietary cravings, which asks if women have experienced cravings for foods within various food groups. The definition of cravings is not specified in this question. Thus cravings are defined as they are in common usage, which is an intense, urgent, or abnormal desires or longing . All of the studies conducted to date in pregnancy have used the same or similar definition of cravings. Item I-3 asks “Since becoming pregnant, I have had cravings for” a list of possible responses, which include sweets, salty foods, meat, starchy foods, fruits/vegetables, and other foods. Respondents are asked to check off as many categories as is applicable for their situation. The MWS is completed twice in pregnancy, once at entry to care and again in the last half of pregnancy.

Cravings in the sample were described using three different variables: cravings of any type, cravings within food groups, and total numbers of cravings. ‘Cravings of any type’ were defined as checking off at least one craving food group out of the six included on MWS item 3 (I-3). ‘Cravings within food groups’ was determined by which specific food group categories were checked off by the respondent on item 3. Women were asked to check off as many food groups as applied for their situation. For example, if a woman check off cravings for sweets and cravings for salty foods, she would be considered to have two ‘cravings of any type’ and ‘cravings within’ the sweet group and ‘cravings within’ the salty food group.

Figure 2 depicts these variables. In Figure 2, woman A would be considered to have ‘cravings of any type’ for both early and late pregnancy as she checked off at least one craving group in each time period. For the variable ‘cravings within food groups’, she would be coded as having cravings within the protein and sweet groups in early pregnancy and coded as having craving within the salty and fruit/vegetable groups in late pregnancy.

Woman A			Cravings
Cravings	T1	T2	<u>Cravings of Any Type</u>
Sweets	✓		Checked off at least one craving?
Salty		✓	Early Pregnancy: Yes
Protein	✓		Late Pregnancy: Yes
Fruits/vegetables		✓	<u>Cravings within Food Groups</u>
Starches			Early Pregnancy
Other			Sweets, Proteins
			Late Pregnancy
			Salty, Fruits/vegetables

Figure 2 *Craving Variables*

Of note is that some answers on the ‘Other’ craving category were recoded depending on whether a woman filled out the accompanying fill-in box asking her to describe her specific ‘other’ cravings. If a woman did not complete the fill-in box next to the other category, she remained in the ‘other’ category. However, if she wrote in a specific food in the fill-in box, whether she stayed in the ‘other’ category depended on her answer. For example, some women reported having cravings for foods such as fast food. Fast foods are not one of the standard items listed on the MWS. Other women reported specific foods, such as salad, in the fill-in box. This latter option could fit into one of the standard categories, but the first could not. Where possible, items listed in the ‘other’ item were recoded into one of the standard craving categories (e.g., sweets, fruits/vegetables). Those foods that did not match a food craving group stayed in the ‘other’ category. In the example above, cravings for fast food would remain in the ‘other’ category and cravings for salad would be recoded into the fruit/vegetable category. Appendix B describes which foods listed in the ‘other category’ foods were recoded and those that remained in the other category.

The variable, total number of cravings, was created by summing the number of craving food groups checked by the respondent on item 3 on the MWS T1 and the MWS T2. Six food groups were

listed on each MWS (i.e., sweet, fruit/vegetable, starchy foods, protein, salty foods, and other). Therefore, the total number of cravings could range from 0 to 12. For example, women who checked off cravings for sweets, meats, and salty foods would be considered to have three cravings.

Weight Measures. Data needed to calculate BMI and prenatal weight gain were taken from the record. In order to calculate a woman's early pregnancy BMI, a woman's height and weight was taken from the first prenatal visit. The first and last weight in pregnancy was taken from the record to calculate prenatal weight gain. EDC and the date of the first and last weight in pregnancy were taken from the record to calculate at what gestational age the first and last weight was obtained. Knowing the gestational age at the time of first and last weight was necessary to determine if women had a prenatal weight at < 13.4 weeks and ≥ 37 weeks of pregnancy, which were the two designated time periods used to calculate total weight gain. The earliest and latest weight available in these two time periods, respectively, were used to calculate weight gain in pregnancy.

Weight measures included: BMI, BMI category, adherence to IOM recommendations, and weight-gain ratio. A woman's BMI was calculated from the earliest documented height and weight obtained in the first trimester of pregnancy using the standard formula, (kg/m^2) . Weight was also described by BMI category: underweight ($< 18.5 \text{ kg}/\text{m}^2$), normal weight ($18.5\text{-}24.9 \text{ kg}/\text{m}^2$), overweight ($25\text{-}29.9 \text{ kg}/\text{m}^2$), or obese ($\geq 30 \text{ kg}/\text{m}^2$). Calculating BMI categories was necessary because prenatal weight recommendations are based on BMI category. Thus, it was necessary to first categorize a woman's BMI as being under weight, normal weight, overweight, or obese as the first step in calculating whether she gained more weight than recommended by the IOM.

Adherence to IOM recommendations is based on 2009 IOM recommendations, which vary by a woman's pre-pregnancy BMI. Allowable weight ranges differ by BMI category (Institute of Medicine & National Research Council, 2009). Total prenatal weight gain was calculated by subtracting the first weight obtained at ≤ 13.4 weeks of pregnancy from the last weight obtained at ≥ 37 weeks of pregnancy. Women's prenatal weight gain was categorized into whether they under-gained, met, or exceeded the

IOM 2009 prenatal weight gain recommendations. This determination was made by comparing a woman's weight gain to the allowable weight gain range set by the 2009 IOM for underweight, normal weight, overweight, and obese women (Table 1).

The weight-gain ratio is the primary outcome measure in this study. The weight-gain ratio is a way of creating a continuous variable that reflects excessive weight gain and has been used by other researchers interested in exploring determinants of prenatal weight gain (Webb et al., 2009). The weight-gain ratio was calculated as follows: a woman's total weight gain was divided by the upper limit of the allowable weight range based on her BMI. This calculation was used to determine the degree to which a woman exceeded the 2009 IOM guidelines. For example a woman with a BMI of 23 and a weight gain of 45 lbs would be allowed to gain a maximum of 35 lbs according to the 2009 IOM recommendation. This woman would have a weight ratio of 1.28 ($45 \div 35$), which is equivalent to exceeding her allowable weight range by 28%. If cravings are associated with prenatal weight gain, then women with cravings were expected to have a significantly higher weight-gain ratio compared to women without cravings. However, if cravings are associated with less weight gain, then the weight-gain ratio would be less than one.

Data Management

This section describes the processes that were used in the management of data in this study.

Confidentiality

Subjects were assigned an individual identification number. In order to preserve confidentiality, a study log linking the name, medical record number, and subject ID was kept on a pass-word protected computer located in a locked office at the SBHC. Study data was taken from medical records on key study variables and entered into a separate study data set in which identifiers were removed.

Data Collection and Cleaning

Data were taken from the medical record of women to determine eligibility and to answer research questions. Data was pulled from the electronic record using electronic data abstraction tools where

possible. Medical charts were reviewed to look for data not available through electronic sources. Data were explored using univariate analysis. Descriptive statistics were run for each study variable to identify implausible and missing data and prompted a return to the medical record to correct these problems if possible.

Missingness

Three issues with missing data occurred. First, missing data occurred because of irregular or sporadic care. If women came to care early and remained in care, data taken from the medical records was readily available. However, some women entered care too late, left care too early or transferred care making it impossible to determine whether their prenatal weight gain met the IOM recommendations. Women without documented early or late weight were excluded from the sample due to incomplete data.

Second, data on cravings was missing for some women. For example, some women did not complete a MWS twice in pregnancy. Others did not fill out a MWS before the 20th week of pregnancy. Because one of the hypotheses was that women exposed to cravings throughout their pregnancy would gain more weight than those with no or transient cravings, having a MWS completed in early and late pregnancy was necessary to answer the research question on the associations between cravings and prenatal weight gain. Therefore, these women were also excluded from the sample due to incomplete data.

Third, data on some variables needed to address secondary questions was missing. While all versions of the MWS included questions on cravings, questions on stress and depression were not on the original version of the MWS. Therefore, data on stress and depressive symptoms were missing in the sample for women completing the original version of the MWS. Because stress and depression were independent variables hypothesized to be related to the numbers of cravings women reported on the MWS, women with incomplete data on these variables were retained in the sample but dropped from analyses on predictors of cravings. Regression analyses were conducted to determine the relationships

between independent variables and the number of cravings reported in pregnancy for the subset of the sample with complete data on all predictors.

Data Analysis

Data analysis was conducted to describe the sample and to answer the research question. Descriptive statistics were used to describe the sample by demographic data, parity, smoking status, BMI, and adherence to IOM weight gain recommendations. Frequencies of ‘cravings of any type’ and ‘cravings within food groups’ were calculated as the percentage of the sample reporting cravings on two MWS in pregnancy. Statistical assumptions were checked for outcome variables, including checking for normalcy using graphs of skew and kurtosis, P-P plots, and Kolmogorov-Smirnov tests. Determining normalcy was needed in order to determine whether parametric or non-parametric statistical tests should be used in the analyses. Further details on testing the data for assumptions can be found in Chapter 4.

Differences in mean weight-gain ratios were tested using Kruskal-Wallis tests between women reporting cravings of any type in four time periods: never, early pregnancy only, late pregnancy only, and both time periods. Differences in mean weight-gain ratios were tested using one-way ANOVAs with planned contrasts for women reporting having cravings within a specific food group in early pregnancy only, late pregnancy only, and in both time periods. Bivariate correlation analyses were used to examine the relationships between predictors and numbers of craving reported in pregnancy. Multiple regression analyses were conducted to determine if risk factors were predictive of the numbers of cravings women reported in pregnancy.

Conclusion

This chapter discussed the methodology used in this study. Data were taken from existing medical records of pregnant women who received care in an urban community health center to describe the frequency of cravings, explore associations between cravings and prenatal weight gain, and examine relationships between predictors of cravings and the numbers of cravings women report in pregnancy.

Data collection and data entry followed established procedures to insure appropriate data management and safeguard confidentiality.

CHAPTER 4 RESULTS

The purpose of this retrospective chart review study was to describe the frequency of cravings in pregnancy and the associations between cravings and prenatal weight gain, as well as to determine if certain characteristics of the sample were predictive of reporting a greater number of cravings in pregnancy. The results of this retrospective chart review study are presented in this chapter. This chapter is organized into the following sections: a description of the sample and a discussion of the study results. For the study results, this chapter will first describe the frequency of cravings in pregnancy, then describe the associations between cravings and prenatal weight gain, and conclude with a discussion of the relationships between potential predictors of cravings and the numbers of cravings women reported in pregnancy.

Sample

This retrospective chart review study examined the health care records of all women who received prenatal care at the Montefiore South Bronx Health Center (SBHC) between January 1, 2006 and December 31, 2012 ($N = 1,259$). Women were excluded from the analysis of all research questions for two reasons, either they did not meet one of the eligibility criteria or their charts lacked key information needed to answer the research questions. The sample flow chart is depicted in Figure 3.

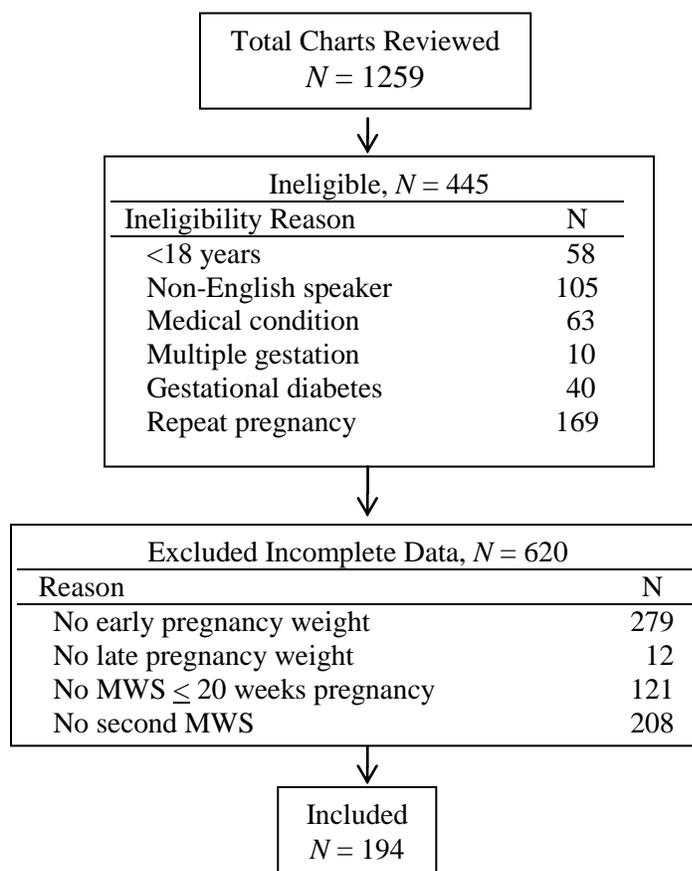


Figure 3: Sample Flow Chart

Women were eligible to participate in this study if they had healthy, singleton, low-risk and full-term pregnancies. Women who are younger or have medical conditions may have different physiologic needs or care that can affect their weight or the counseling and educational support they receive about nutrition in pregnancy. Consequently, women were ineligible if they (1) were younger than 18 years, (2) had a multiple gestation (i.e., pregnant with twins or other multiple fetuses), (3) developed gestational diabetes, or (4) had a medical condition requiring on-going supervision by the OB High-Risk Clinic.

Women were also ineligible if they were non-English speakers; the craving instrument was only available in English or Spanish, and the Spanish version had not been validated for cultural congruency among the various Hispanic populations receiving care at the SBHC. Hispanic women receiving care at the SBHC are affiliated primarily with Mexico, Puerto Rico, Dominican Republic, and Honduras. Lastly women with repeated pregnancies were also ineligible. Over the six years of this study, some women became

pregnant with a second or third pregnancy. Only one pregnancy per woman was eligible to be included in the analysis. If a woman had several pregnancies, the pregnancy with the most complete data was retained in the sample. Of note is that women could have multiple reasons for being ineligible.

Critical information needed from the chart included (1) data needed to determine if women met the weight gain recommendations set by the IOM and (2) having data on cravings in both early and late pregnancy. A BMI obtained in the first trimester and a weight obtained in the last three weeks of pregnancy was necessary to determine whether women gained an appropriate amount of weight. The IOM makes recommendations about the appropriate amount of weight women should gain based on their early pregnancy BMI. (Table 1 describes the recommended weight gain ranges set by the IOM). Women must have completed the sections on the MWS relevant to cravings. Because the principle question being addressed in this study was whether cravings were associated with prenatal weight gain, women needed two completed MWS: one at $\leq 20^{\text{th}}$ week of pregnancy and another in late pregnancy. Women who did not have these critical elements were excluded from the sample due to incomplete data. A total of 1,065 women were dropped from the sample (445 for not meeting eligibility criteria and 620 for missing data), leaving a total of 194 women in the sample.

Using T tests and Chi-square analyses for continuous and categorical data, respectively, women included in the sample ($n = 194$) were compared to those excluded from the analysis due to incomplete data ($n = 620$) to determine if there were differences between groups on factors known in the literature to affect prenatal weight gain: age, parity, smoking, and BMI. These characteristics, as well as demographic data, are listed in Table 4. Women included ($n = 194$) in the sample were one year older ($M = 26.8$, $SD = 5.2$) than those excluded from the sample ($n = 620$) due to incomplete data ($M = 25.9$, $SD = 5.3$, $t = -2.257$ (812), $p = .025$). There were no differences in parity between groups, one-third of women in both the included and excluded groups were primiparous. Multiparous women had similar numbers of children. No differences were seen in weight measures, whether weight was measured by mean BMI or frequency within the four BMI categories (i.e., underweight, normal weight, overweight, or obese). Compared to

those excluded due to incomplete data, women included in the sample were significantly less likely to smoke cigarettes (15.5% vs. 23.1%, respectively, $\chi^2(1) = 5.123, p = .024$), and if they smoked, reduced their level of smoking in pregnancy to a greater degree. Women included in the sample reduced the number of cigarettes they consumed by 94.1% compared to 76.2% for women with incomplete data, $t(146) = -4.864, p < .001$.

Women differed significantly by racial composition between those included and those excluded due to incomplete data, $\chi^2(4) = 10.171, p = .038$. There were a higher percentage of women who identified themselves as being Multi-Racial and fewer women who identified themselves as being White or African American in the included compared to the excluded group. No differences were seen between groups in ethnicity.

In summary, significant differences were found between those included and excluded in the sample due to incomplete data on age, smoking, and racial composition. Those included in the sample were one year older; were less likely to smoke cigarettes, and if they did, had a greater reduction in the numbers of cigarettes smoked in pregnancy; and were more likely to identify themselves as being Multiracial and less likely to identify themselves as being White or African American compared to women excluded due to incomplete data.

Table 4
Comparison of Included vs. Excluded Cases

Characteristic		Included	Excluded	Statistic, <i>p</i>
	N	194	620	
Demographics				
Age	M (SD)	26.8 (5.2)	25.9 (5.3)	$t(812) = -2.257, p=.025$
	Range	18.1, 42.0	18.0, 43.0	
Adolescent < 21 years	%	13.9	19.7	$\chi^2(1) = 3.278, p = .070$
Parity	M (SD)	1.1 (1.2)	1.3 (1.3)	$t(812) = 1.328, p = .185$
	Range	0, 6	0, 8	
Primiparous	%	34.0	34.8	$\chi^2(1) = .044, p = .834$
Ethnicity, Hispanic				$\chi^2(2) = .685, p = .710$
Yes	%	61.3	59.2	
No	%	35.6	38.4	
Declined or unknown	%	3.1	2.4	
Race				$\chi^2(4) = 10.171, p = .038$
Multiracial	%	42.3	31.8	
African American	%	37.1	40.0	
White	%	14.4	18.1	
Other	%	0	1.4	
Declined	%	6.2	8.7	
Health Characteristics				
BMI	M (SD)	28.3 (6.9)	28.7 (7.0) ^a	$t(799) = .608, p = .544$
BMI Category				$\chi^2(3) = .404, p = .939$
Underweight, < 18.5 kg/m ²	%	3.6	3.0 ^a	
Normal weight, 18.5 – 24.9 kg/m ²	%	32.5	31.0 ^a	
Overweight, 25 – 29.9 kg/m ²	%	27.8	28.8 ^a	
Obese, ≥ 30 kg/m ²	%	36.1	37.2 ^a	
Smoking				
Current smoker	%	15.5	23.1 ^b	$\chi^2(1) = 5.123, p = .024$
Cigarettes/d before pregnancy	M (SD)	9.0 (6.2)	10.6 (7.0) ^c	$t(152) = 1.052, p = .294$
% decrease in cigarettes smoked	M % (SD)	94.1(10.7)	76.2 ^d (0.33)	$t(146) = -4.864, p < .001$

^aMissing BMI, *n* = 13, BMI categories reported as valid percentage; ^bMissing smoking, *n* = 5, reported as valid percentage; ^cMissing *n* = 13; ^dMissing, *n* = 19.

Research Questions

This section will present the data analysis for the research questions, first on the frequency of cravings (Research Questions 1 and 2), then on the associations between cravings and weight gain (Research Questions 3), and lastly on predictors of the numbers of cravings (Research Questions 4).

Frequency of Cravings in Pregnancy

There are two research questions on the frequency of cravings: Research Question 1: What is the frequency of craving in early or late pregnancy? And Research Question 2: What is the frequency of

reporting cravings throughout pregnancy? The data analysis for both questions was based on an analysis of the frequency of cravings reported on the first and second MWS. The first MWS was completed on average at 9.7 ($SD = 2.9$) weeks and the second MWS on average at 31.3 ($SD = 3.7$) weeks gestation. The following section will discuss the results of the first and second research question.

There are two craving variables used in this analysis: ‘cravings of any type’ and ‘cravings within food groups’. The variable ‘cravings of any type’ was defined as checking off at least one type of cravings on the MWS item-3. MWS item-3 had the following response options, cravings for (1) sweets, (2) fruits/vegetables, (3) salty food, (4) starchy food, (5) protein, and (6) other. If a woman checked off at least one of these choices she was considered to have ‘cravings of any type.’

‘Cravings within food group’ was defined by the specific food group(s) a woman checked off on MWS item-3. For example, if a woman checked the box ‘cravings for sweets’ she was considered to have a sweet craving. Note that a woman could choose as many categories as applied for her particular situation, and consequently, can report having multiple cravings.

Research Question 1: What is the Frequency of Experiencing Cravings in Early or Late Pregnancy?

Data Analysis. Frequencies of cravings in early pregnancy by ‘cravings of any type’ was calculated as the percentage of women in the sample ($n = 194$) who checked off at least one craving box on the first MWS completed before the 20th week of pregnancy. Frequency of cravings in late pregnancy by ‘cravings of any type’ was calculated as the percentage of women in the sample ($n = 194$) who checked off at least one craving box on the second MWS completed later in pregnancy.

Frequencies of ‘cravings within food groups’ were determined by which specific craving box(es) a woman checked on the MWS. The cravings options were sweets, salty foods, protein, starchy foods, fruits/vegetables, and other. Frequencies of ‘cravings within food groups’ in early pregnancy was calculated as the percentage of the women in the sample ($n = 194$) who checked off that they had cravings within a particular food group on the first MWS. Frequencies of ‘cravings within food groups’ in late

pregnancy was calculated as the percentage of women in the sample ($n = 194$) who checked off that they had cravings within a particular food group on the second MWS.

Results. The frequency of cravings as reported by women on the MWS in early pregnancy and the MWS completed later in pregnancy by ‘cravings of any type’ and ‘cravings within food groups’ are displayed in Table 5.

Table 5

Frequency of Cravings in Early or Late Pregnancy, N = 194

Type of Craving	Early Pregnancy, MWS T1	Late Pregnancy, MWS T2
	N (%)	N (%)
Cravings of Any Type	146 (75.3)	158 (81.4)
Cravings within Food Groups		
Fruits/vegetables	94 (48.5)	97 (50.0)
Sweets	47 (24.2)	70 (36.1)
Salty foods	36 (18.6)	41 (21.1)
Starchy foods	43 (22.2)	36 (18.6)
Protein	33 (17.0)	40 (20.6)
Other	11 (5.7)	8 (4.1)

Cravings were reported by 75.3% of women filling out the early MWS and by 81.4% of women who completed a second MWS later in pregnancy. Of the food groups, cravings for fruits/vegetables and sweets were the most common in both time periods. Cravings overall were more prevalent later in pregnancy. The food group with the largest increase in prevalence in late pregnancy, compared to early pregnancy, was cravings for sweets.

Research Question 2: What is the Frequency of Reporting Cravings Throughout Pregnancy?

“Research question 2” addresses the pattern of cravings across pregnancy. Women were categorized into four exclusive groups based on the timing of cravings in pregnancy: (1) never, (2) early

pregnancy only, (3) late pregnancy only, and (4) early and late pregnancy. Cravings were described by two different measures: (1) ‘cravings of any type’ and (2) ‘cravings within a specific food group’.

The analysis and results for ‘cravings of any type’ will be discussed first. The analysis and results for the measure ‘cravings within a specific food group’ will follow.

Cravings of Any Type.

Data Analysis. For the measure, ‘cravings of any type’ women were categorized into one of the following four groups based on how they completed a MWS in early and late pregnancy: Group 1: no cravings of any type in early or late pregnancy, Group 2: cravings of any type in early pregnancy only, Group 3: cravings of any type in late pregnancy only, and Group 4: cravings of any type occurring in both early and late pregnancy. Frequency of ‘cravings by any type’ was calculated at the percentage of the women in the sample who reported cravings within these four time periods.

Results. Table 6 describes the frequency of ‘cravings of any type’ as reported on the MWS 1 and the MWS 2 in the four time periods.

Table 6

Timing of Cravings of Any Type in Pregnancy, N = 194

Timing in Pregnancy			
None	Only early pregnancy	Only late pregnancy	Both early and late pregnancy
n (%)	n (%)	n (%)	n (%)
18 (9.3)	18 (9.3)	30 (15.4)	128 (66.0)

Only 9.3% of the sample reported experiencing no cravings at any time point and two-thirds reported having cravings of some type in both early and late pregnancy.

Cravings Within Food Groups.

Data Analysis. The frequency of ‘cravings within the various food groups’ was also calculated using four time periods. Four groups were created for each food group category (i.e., Group 1: no cravings within a designated food group in early or late pregnancy, Group 2: cravings within a designated food group in early but not late pregnancy, Group 3: cravings within a designated food group in late but

not early pregnancy, and Group 4: cravings within a designated food group which occurred in both early and late pregnancy). Frequencies of ‘cravings within a food group’ were calculated as the percentage of the sample ($N = 194$) who reported craving within a particular food group in these four time periods.

Results. Results are displayed in Table 7. The most common pattern within each food group was ‘none’, meaning that a woman did not experience cravings within that particular group. Cravings occurring in both early and late pregnancy were most commonly reported for fruits and vegetables (33.5%) followed by sweets (16.5%).

Table 7

Timing of Cravings within Food Groups in Pregnancy, $N = 194$

Cravings	Timing			
	None	Only early pregnancy	Only late pregnancy	Both early and late pregnancy
Food Groups	n (%)	n (%)	n (%)	n (%)
Fruits/vegetables	68 (35.1)	29 (14.9)	32 (16.5)	65 (33.5)
Sweets	109 (56.2)	15 (7.7)	38 (19.6)	32 (16.5)
Salty foods	133 (68.6)	20 (10.3)	25 (12.9)	16 (8.2)
Protein	140 (72.2)	14 (7.2)	21 (10.8)	19 (9.8)
Starchy foods	127 (65.5)	31 (16.0)	24 (12.4)	12 (6.1)
Other	178 (91.9)	8 (4.1)	5 (2.6)	3 (1.4)

Summary.

In summary, cravings were common, affecting the majority of women. Women reported cravings for fruits/vegetables and sweets most frequently.

Dietary Cravings and Prenatal Weight Gain

This section will first describe the weight gain patterns of women in the sample and then address the results of research question 3 on the association between dietary cravings and prenatal weight gain.

Prenatal Weight Gain in the Sample. The percentage of the sample gaining less than, equal to, or more than recommended by the IOM is listed in Table 8 by BMI category. In this sample ($n = 194$), 46.4% gained above, 34.5% met, and 19.1% gained less than what is recommended for pregnant women. Gaining more than recommended was the most common pattern for overweight ($n = 54$) and obese

women ($n = 70$). However, the most common pattern for normal weight women ($n = 63$) was to meet the recommendations set by the IOM and for underweight women ($n = 7$) it was to gain less than recommended. On average, underweight women gained 35.0 lbs ($SD = 16.3$), normal weight women 32.6 lbs ($SD = 10.5$), overweight women 28.9 lbs ($SD = 13.6$), and obese women 19.4 lbs ($SD = 11.7$).

Table 8

Adherence to IOM Weight Gain Recommendations, N=194

BMI Categories	Institute of Medicine Weight Gain Recommendations			
	Under N (%)	Met N (%)	Over N (%)	Total N (%)
Underweight, $< 18.5 \text{ kg/m}^2$	3 (42.8)	2 (28.6)	2 (28.6)	7 (3.6)
Normal weight, $18.5 - 24.9 \text{ kg/m}^2$	12 (19.1)	28 (44.4)	23 (36.5)	63 (32.5)
Overweight, $25 - 29.9 \text{ kg/m}^2$	8 (14.8)	13 (24.1)	33 (61.1)	54 (27.8)
Obese, $\geq 30 \text{ kg/m}^2$	14 (20.0)	24 (34.3)	32 (45.7)	70 (36.1)
Total	37 (19.1)	67 (34.5)	90 (46.4)	194 (100)

Not only did nearly half the sample gain more weight than recommended by the IOM, overweight women gained well above the upper limit of the weight gain recommendations set by the IOM. The degree to which women exceeded the IOM recommendations was measured by the weight-gain ratio. The reference point when calculating this measure is the upper limit of allowable weight within each BMI category. Women who gain more weight than recommended by the IOM have a weight-gain ratio of greater than one. Women who gain less than or meet the IOM recommendations have a weight-gain ratio of less than one. Thus, the weight-gain ratio reflects the weight gain pattern of all women in reference to gaining above or below the upper allowable limit set by the IOM. For example, a normal weight woman has a maximum allowable weight of 35 lbs: therefore, if she gained 35 lbs, she would have gained exactly at the upper limit of the recommended range and her weight-gain ratio would be one. If she gained 40 lbs, her weight-gain ratio would be 1.14. This would indicate that she gained 14% more than recommended by the IOM. The mean weight-gain ratio by BMI category is listed in Table 9. In this study, underweight,

normal weight, and obese women gained on average close to the upper limit of the acceptable weight gain range set by the IOM. However, on average, overweight women exceeded this upper limit by 41%.

Table 9

Weight-Gain Ratio by BMI Category, N=194

BMI Categories	N	Weight-Gain Ratio Mean (SD)
Underweight, < 18.5 kg/m ²	7	0.88 (0.41)
Normal weight, 18.5 – 24.9 kg/m ²	63	0.93 (0.30)
Overweight, 25 – 29.9 kg/m ²	54	1.41 (0.70)
Obese, ≥ 30 kg/m ²	70	0.97 (0.59)
Total	194	

Research Question 3: Are Cravings Associated with Prenatal Weight Gain? While the above section described the weight gain patterns of the sample, the following section will address the data analysis and results related to Research Question 3: Are cravings associated with prenatal weight gain?

Women who reported craving were hypothesized to gain more weight in pregnancy than women who did not report cravings. Women who reported having cravings in early, as well as late, pregnancy were hypothesized to have greater weight gain compared to women in other time periods (i.e., no cravings or cravings that occurred only in early or only in late pregnancy). Women reporting cravings in both early and late pregnancy would have received the ‘highest dose’ of cravings and therefore may be at greatest risk of gaining above the upper limit of the weight range recommended by the IOM.

The key measures used to address Research Question 3 were measures of cravings and prenatal weight gain. Two different independent variables on cravings were used: ‘cravings of any type’ and ‘cravings within food groups’. Two different analyses were run, one for each of these independent variables, to test for differences in the means between groups based on the timing of when cravings occurred in pregnancy.

For the independent variable ‘cravings of any type’, four time periods were used: (1) no cravings of any type at any point in pregnancy, (2) cravings of any type in only early pregnancy, (3) cravings of

any type in only late pregnancy, and (4) cravings of any type in both early and late pregnancy. This was done to determine whether cravings in general were associated with prenatal weight gain. If cravings do not impact weight, the means of the weight-gain ratio would be similar in all four groups.

For the independent variable ‘cravings within food groups’, three time periods were used: (1) cravings within the designated food group in early pregnancy only, (2) cravings within the designated food group in late pregnancy only, and (3) cravings within the food group in both early and late pregnancy. This was done to test if reporting cravings within specific food groups were associated with prenatal weight gain *among* women who had any degree of cravings in that specific food group. Women reporting cravings in both early and late pregnancy were hypothesized to gain more weight than those with cravings in only early or only late pregnancy. This analysis will test if the ‘dose’ of cravings is associated with weight gain among women reporting a specific craving. The dependent variable used in all analyses was the weight-gain ratio.

Exploring Assumptions. Before running an analysis, it is important to explore the characteristics of the data to determine which statistical test is most appropriate to use. ANOVAs are robust statistical tests that can detect differences in means between three or more groups (Field, 2009). Several assumptions must be checked before ANOVAs can be run. One assumption is that the distribution of the dependent variable follows a normal distribution (Field, 2009). The dependent variable, the weight-gain ratio, was assessed using the Explore function in SPSS for all women in the sample ($N=194$) (SPSS Statistics). A visual inspection of the histogram of the weight-gain ratio demonstrated a distribution with positive skew, with outliers on the right tail and a clustering of values close to the vertical axis. Both the P-P plot, which plots the individual values of the chosen variable along the cumulative probability of the normal distribution, and the Q-Q plot, which plots the quartiles of the values along the Z distribution, should hug the line if the distribution is normal (Field, 2009). Values fell off the line of the P-P plot and the Q-Q plot at the extreme right end of the line indicating non-normality. Examination of box plots revealed four cases with extreme values.

Tests of normality were conducted. Z values of skewness and kurtosis of the distribution of the weight-gain ratio were calculated by dividing the values of skewness and kurtosis by their respective standard errors; the value of skewness ($Z = 5.45$) and kurtosis ($Z = 5.74$) indicate that the distribution was not normal. A normal distribution has a mean of zero. Z values for kurtosis and skewness are acceptable if they fall between -1.96 and 1.96 as these values represent 95% of the values below or above the normal distribution mean of zero. Since the Z score of skewness and kurtosis are well above this, the distribution of the weight-gain ratio is not normal. In addition, the Kolmogorov-Smirnov test, which tests whether the distribution of the variable in question is different than a comparable normal distribution with the same mean and distribution, should be non-significant if the variable is normally distributed (Field, 2009). The value was $D(194) = .113, p < .001$. By all measures, the distribution of the variable, the weight-gain ratio, was not normal.

Two approaches are appropriate if the distribution of the dependent variable is not normal. First, the accuracy of the data should be checked. One of most common reasons that a distribution is non-normal is that there are outliers in the data. Data entry errors are a common cause of a value appearing to be an outlier. The four univariate outliers identified on the boxplots were rechecked to confirm that there were no errors in data entry. No errors were found. Second, the dependent variable can be transformed or outliers removed to improve the normalcy of its distribution. However, the Kolmogorov-Smirnov test of the Square-Root transformation of the weight-gain ratio demonstrated no improvement in the quality of the distribution, $D(194) = .095, p < .001$. Neither did removing the four outliers and then performing a Square-Root transformation; the Kolmogorov-Smirnov test remained significant, $D(190) = .079, p = .029$. Therefore, because no improvements were noted, the untransformed weight-gain ratio including all cases was used in the analyses examining the associations between cravings and prenatal weight gain.

Because ANOVAs are robust tests, they can be used even if the dependent variable is not normally distributed. According to Field (2009), ANOVAs can be used when the distribution of the dependent variable does not follow a normal distribution as long as cells sizes are equal. If cell sizes are

uneven, then ANOVA can still be used with certain caveats. If cell sizes are unequal there needs to be at least 20 degrees of freedom and the smallest response category has to contain at least 20% of the responses. If both of these criteria are not met, then at least 40 degrees of freedom is needed to be able to use an ANOVA if cell sizes are unequal (Field, 2009). The use of ANOVAs also requires that other conditions are met, that the dependent variable is measured at the interval level, that there is independence between groups, and that the variance between groups is similar (Field, 2009). If these criteria are not met, then use of a non-parametric test is more appropriate. The reasoning behind the choice of a particular test is discussed below under Data Analysis and Results.

Data Analysis and Results. Two different analyses were run for each of the independent variables. This section will first present the analysis and results for ‘craving of any type’ and then present the analysis and results for ‘cravings within food groups.’

Craving of Any Type. To determine if cravings of any type were associated with prenatal weight gain, women were categorized into four groups based on their responses on the MWS completed in early and late pregnancy: (1) no cravings in pregnancy, (2) cravings of any type in early pregnancy only, (3) cravings of any type in late pregnancy only, and (4) cravings of any type which occur in both early and late pregnancy. The dependent variable used in this analysis was the weight-gain ratio. Weight-gain ratios in these four time periods by ‘cravings of any type’ are displayed in Table 10 below.

Table 10

Timing of ‘Cravings of Any Type’ in Relation to Prenatal Weight Gain, N=194

Cravings	Timing							
	None		Early Pregnancy		Late Pregnancy		Both Early and Late	
	Wt.-Gain Ratio		Wt.-Gain Ratio		Wt.-Gain Ratio		Wt.-Gain Ratio	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Any Type	18	1.15 (0.74)	18	1.14 (0.51)	30	1.10 (0.64)	128	1.05 (0.55)

Non-parametric tests were chosen to determine if there were differences between the means of the weight-gain ratio between women reporting ‘cravings of any type’ in the four time periods. Two

assumptions necessary to run an ANOVA were not met. First, the dependent variable, the weight-gain ratio, was not normally distributed, as discussed above. Second, there was marked variation in the numbers of women within the four time periods with the smallest cell containing 18 cases and the largest cell containing 128 cases as seen in Table 10. Because two assumptions were broken (i.e., a non-normal distribution of the weight-gain ratio and uneven cell sizes), an analysis of the differences in the mean weight-gain ratio between these four groups was conducted using the Kruskal-Wallis Test.

The Kruskal-Wallis test is the non-parametric test equivalent of ANOVA. There are two versions of the Kruskal-Wallis test, one based on detecting differences in ranks and the other based on detecting differences in medians between groups (Field, 2009). Both tests can be used if cell sizes are unequal or variables have non-normal distributions. Both are based on Chi-square distributions, which test if there are differences in the distributions, not the means, between groups. Of the two, the Kruskal-Wallis test based on ranks is more rigorous as there are more categories (ranks) within which values can be placed compared to the median which has only two (i.e., above or below the median).

Kruskal-Wallis rank and median tests were run between ‘cravings of any type’ as the independent variable and weight-gain ratio as the dependent variable. No differences were seen between the mean of the weight-gain ratios in women who reported no cravings ($M = 1.15$, $SD = 0.74$), reported cravings in early pregnancy only ($M = 1.14$, $SD = 0.51$), reported cravings in late pregnancy only ($M = 1.10$, $SD = 0.64$), and reported cravings in both early and late pregnancy ($M = 1.05$, $SD = 0.55$), Kruskal-Wallis rank test, $H(3) = 1.358$, $p = .72$ and Kruskal-Wallis median test, $H(3) = 3.638$, $p = .30$. Weight gains of women reporting craving of any type in early pregnancy, late pregnancy, or both time periods did not differ from the prenatal weight gain of women who reported never having cravings in pregnancy. No dose effect of cravings was seen in relation to prenatal weight gain.

Cravings Within Food Groups. Not all cravings may be equal. It may be that cravings for specific foods, not general food cravings, are associated with higher weight gain. Cravings for higher caloric foods were hypothesized to be associated with higher prenatal weight gain.

The weight-gain ratio was calculated within each craving food group for all women in the sample, $N = 194$. Each food group category was analyzed separately. Based on the responses on the MWS in early and late pregnancy, women were categorized within each food group into one of four groups: (1) no cravings within a designated food group at any point in pregnancy, (2) cravings within a designated food group only in early pregnancy, (3) cravings within a designated food only in late pregnancy, and (4) cravings within a designated food both in early and late pregnancy. The weight-gain ratios within each food group that correspond to these time periods are listed in Table 11 below.

Table 11

Timing of 'Cravings Within Food Groups' in Relation to Prenatal Weight Gain, $N=194$

Cravings within Food Groups	Timing of Cravings in Pregnancy							
	None		Early Pregnancy		Late Pregnancy		Both Early and Late	
	<i>Wt. Gain Ratio</i>		<i>Wt. Gain Ratio</i>		<i>Wt. Gain Ratio</i>		<i>Wt. Gain Ratio</i>	
	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)
Sweet	109	1.07 (0.58)	15	1.00 (0.48)	38	<i>1.18 (0.59)^a</i>	32	1.04 (0.61)
Salty food	133	1.07 (0.58)	20	1.12 (0.59)	25	1.08 (0.62)	16	1.08 (0.53)
Protein	140	1.05 (0.61)	14	1.12 (0.40)	21	1.14 (0.60)	19	1.18 (0.46)
Starchy food	127	1.05 (0.56)	31	1.01 (0.54)	24	1.11 (0.61)	12	<i>1.47 (0.70)^a</i>
Fruit/vegetable	68	1.08 (0.58)	29	1.02 (0.59)	32	1.14 (0.73)	65	1.07 (0.50)
Other	178	1.08 (0.59)	8	.98 (0.38)	5	.96 (0.38)	3	1.14 (0.47)

^a Boldface and italicized cells are higher relative to other timing periods within a specific food group.

On visual inspection of the data, the only cravings within a specific food group that were determined to have a possible association with prenatal weight gain were those for sweets and starches. Among the women who reported craving sweets, the highest weight-gain ratio was seen in women reporting cravings for sweets only in late pregnancy ($M = 1.18$, $SD = 0.59$). Among the women who reported cravings for starches, the highest weight-gain ratio was seen in women reporting cravings in both early and late pregnancy ($M = 1.47$, $SD = 0.70$). Cravings in both of these time points were associated with higher prenatal weight-gain ratios than those seen in women who reported never experiencing cravings at any time in pregnancy ($M = 1.15$, $SD = 0.74$). Of the cravings groups, the strongest potential

candidate for an association between cravings within a specific food group and higher weight gain was for cravings for starchy foods.

Data Analysis 'Cravings Within Food Groups'. Because only cravings within the food groups of starches and sweets were determined to have a potential relationship with prenatal weight gain, the analysis for cravings within food groups was designed to answer two questions: (1) Among women who report cravings for sweets, were there differences in the mean weight-gain ratio between women reporting cravings for sweets in early pregnancy only, late pregnancy only, and in both early and late pregnancy? and (2) Among women who report cravings for starches, were there differences in the mean weight-gain ratio between women reporting cravings for starches in early pregnancy only, late pregnancy only, and in both early and late pregnancy?

Certain conditions must be met in order to use parametric tests, such as ANOVAs, for data analysis. Groups must be independent and the dependent variable must be measured on an interval level. These two conditions were met as women were categorized into exclusive cravings groups depending on the time period in which cravings occurred. The dependent variable was the weight-gain ratio, which is measured on the interval level. Homogeneity of variance, which is the assumption that the variance within the groups are similar, was met as Levene's test was non-significant for both analyses (Levene's (2, 82) = .571, $p = .567$ for sweet cravings and Levene's test (2, 64) = .173, $p = .842$ for starch cravings). When Levene's test is nonsignificant, one cannot reject the null hypothesis that there is no difference in the variance among groups.

Cell sizes were dissimilar among the three time periods (i.e., early pregnancy, late pregnancy, and both early and late pregnancy) for sweet and starchy cravings, but not to such an extent as to preclude the use of ANOVAs. Cell sizes ranged from a low of 15 to a high of 38 among women reporting cravings for sweets and from 12 to 31 for starches. According to Field (2009), ANOVAs can be conducted if there are uneven cell sizes as long as the degrees of freedom are over 20, or if any one response category has less than 20% of all responses, the degrees of freedom are over 40 (Field, 2009). When using one-way

ANOVAs to compare the mean weight-gain ratios within the starch and sweet food groups by the time period, the degrees of freedom for the analysis for cravings for sweets were 82 and 64 for cravings for starchy foods. Thus, only one assumption needed to run ANOVAs was broken: the dependent variable, the prenatal weight-gain ratio, had a non-normal distribution, as discussed above. Because ANOVAs are robust tests, they can be used even if the dependent variable is not normally distributed or if cell sizes are uneven, as long as other conditions, as described above, are met. Therefore, analyses using one-way ANOVAs were conducted to determine if there were differences between the mean weight-gain ratios among women reporting cravings for starches or if there were differences between the mean weight gain-ratios among women reporting cravings for sweets in three time periods.

One-way ANOVAs were run for both analyses with the weight-gain ratio as the dependent variable. Each independent variable had three groups: (1) women reporting cravings in the designated food group only in early pregnancy, (2) women reporting cravings in the designated food group in late pregnancy only, and (3) women reporting craving in the designated food group in both early and late pregnancy using contrasts as depicted in Table 12. The first contrast tested whether having cravings in both early and late pregnancy were associated with higher prenatal weight gain relative to having cravings in only early or only late pregnancy. The second contrast tested whether having cravings in late pregnancy was associated with having higher prenatal weight gain compared to early pregnancy.

Table 12

Contrasts

	Contrast Table		
	Early only	Late only	Both
Contrast 1	-1	-1	2
Contrast 2	-1	1	0

Results: Cravings Within Food Groups. No significant differences were seen in weight gain among women reporting sweet or starch cravings. The weight-gain ratios did not differ by time among women reporting cravings for sweets in early pregnancy only ($M = 1.00$, $SD = 0.48$), late pregnancy

only ($M = 1.18$, $SD = 0.59$), or both early and late pregnancy ($M = 1.04$, $SD = 0.61$), $F(2, 82) = .736$, $p = .482$. A nonsignificant difference was noted in prenatal weight gain between women reporting cravings for starches among the various time periods (i.e., early pregnancy only, late pregnancy only, or in both time periods), $F(2, 64) = 2.54$, $p = .087$, $w = .209$. Women reporting cravings for starches in early pregnancy had a weight-gain ratio on average of 1.01 ($SD = 0.54$), of 1.11 ($SD = 0.61$) if starch cravings were reported only in late pregnancy, and of 1.47 ($SD = 0.70$) if starch cravings were reported to occur in both early and late pregnancy. There was a significant linear trend indicating that as the presence of starch craving increased across time so did prenatal weight gain, $F(1, 64) = 5.06$, $p = .028$. Planned contrasts showed that there were no difference in the prenatal weight gain ratio between women reporting starch cravings only in early pregnancy and those reporting cravings only in late pregnancy, $t(64) = .632$, $p = .530$, $r = .078$. Planned contrasts also showed that persistent cravings, reported in both early and late pregnancy, were associated with higher prenatal weight gain than cravings that were reported to occur only in early or late pregnancy, $t(64) = 2.127$, $p = .037$, $r = .257$.

Summary. In summary, gaining more weight than recommended by the IOM is the most common weight gain pattern seen in this sample, particularly for overweight women. No associations between ‘cravings of any type’ and prenatal weight gain were seen when Kruskal-Wallis rank and median tests were used to test for differences in the means of the weight-gain ratio among women reporting no cravings, cravings of any type in early pregnancy only, cravings of any type in late pregnancy only, and cravings of any type in both early and late pregnancy.

No significant differences were noted in prenatal weight gain among women with cravings within specific food groups. Based on descriptive statistics, the strongest potential relationship between cravings within food groups and prenatal weight gain was with cravings for starches in early and late pregnancy. The results of testing with one-way ANOVAs among women reporting cravings for starches or sweets in three time periods (i.e., early pregnancy only, late pregnancy only, and in both time periods) showed that

women reporting persistent cravings did not have higher prenatal weight gain than those women reporting only transient cravings.

Exploring the association between prenatal weight gain and dietary cravings was significantly compromised by small sample sizes, particularly in the various time periods in which cravings did or did not occur (i.e., no cravings, early or late pregnancy, or both early and late pregnancy).

Predictors of Dietary Cravings

The evidence suggests that cravings are associated with poorer dietary quality (Chao, Grilo, White, & Sinha, 2014; Christensen, 2007). Therefore, even if cravings are not associated with prenatal weight gain, they may still have adverse consequences for fetuses whose mothers have a greater number of cravings. Cravings have been reported in the literature to be more common in women who are (1) stressed or depressed, (2) overweight or obese, or (3) who smoke cigarettes, particularly in those who reduce their level of smoking (Burton et al., 2007; Dickens & Trethowan, 1971). These factors are hypothesized to be associated with having a greater number of cravings in pregnancy.

Research Question (4) asks ‘What factors are predictive of reporting a greater number of cravings in pregnancy?’ The independent variables are the predictors (depression/stress, BMI, and smoking), described below. The dependent variable is the number of cravings a woman reports on the MWS 1 and the MWS 2. This variable was created by summing the numbers of cravings women checked off on the MWS completed in early and late pregnancy. Food categories on the MWS include sweets, protein, starchy foods, fruits/vegetables, salty foods, and others. The total number of cravings in pregnancy can range from 0 to 12, based on the combination of responses from the MWS 1 (range of 0 to 6 responses) and the MWS 2 (range of 0 to 6 responses). Women reported experiencing as few as 0 to a high of 10 cravings. The mean number of total craving was 3.2 ($SD = 1.8$) among women who reported any cravings.

This section will first describe the predictors (depression/stress, smoking, and weight status) for the sample, their correlations with total numbers of cravings, and then present the analysis of Research Question 4.

Description of the Predictors. Data on predictors was obtained either from a review of the clinical notes in the medical records or from questions completed on the MWS. Data obtained from the clinical notes included age, current mental health status, smoking status, and BMI category. Data obtained from the MWS included information on stress levels and depressive symptoms. Each of these predictors will be discussed in the sections below.

Mental Health Status. Several measures were collected that reflect the mental health status of the sample. These measures include: (1) a clinical assessment of the mental health status of an individual woman by the provider; (2) scores on the 2-item PHQ, which is a validated measure of depressive symptomatology, found on the MWS; and (3) scores of the 1-item validated measure on an individual's perceived ability to handle stress, also found on the MWS.

All of the charts were reviewed to determine the mental health status of each woman as determined by the provider. All women at the SBHC are assessed for the need for mental health services and referred as needed, making it possible to categorize women into one of four exclusive categories: (1) None: no mental health concerns, (2) MH Other: no active or prior depression but undergoing enough stress to warrant a referral to the Mental Health Team for support, (3) Depression in remission: prior history of depression, currently in remission, no services needed, and (4) Current active clinical depression requiring care. The mental health status of the sample is described in Table 13.

Table 13

Mental Health Status of the Sample, N=194

Category	N (%)
None	135 (69.6)
MH Other	15 (7.7)
Stress, concrete services ^a	7 (46.7) ^a
Domestic Violence ^a	3 (20.0) ^a
Anxiety ^a	5 (33.3) ^a
Depression, remission	19 (9.8)
Depression, current	25 (12.9)

^a Valid percentage within category of MH other.

Data on symptoms of stress and depression were taken from the MWS. The stress measure is a validated instrument that measures an individual's ability to manage stress on a Likert scale with 1 being 'I don't let things bother me' and 6 being 'I get stressed about things' (Littman et al., 2006). The higher the value, the less an individual is able to manage their stress. The PHQ-2 is a two-item scale that asks about feelings of sadness and lack of enjoyment. It is a validated instrument used to screen for depression (Kroenke et al., 2003). Responses can range from 0 to 2; the higher the value, the greater the depressive symptomatology. Table 14 describes the means and standard deviations of these measures in relation to the mental health categories described above. As would be anticipated, these measures performed in the expected way; i.e., women with no mental health problems scored lowest, those with current depression scored highest, and those with depression in remission or another mental health concern, fell in the mid-range between the two.

Table 14

Scores on Measures of Stress and Depression in Relation to Mental Health Status

Category	Stress						Depressive Symptoms					
	T1 ^a		T2 ^b		Both ^c		T1 ^d		T2 ^e		Both ^f	
	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)
None	70	3.0 (1.5)	70	2.9 (1.4)	64	6.0 (2.6)	73	.41 (.64)	68	.25 (.44)	56	.64 (.82)
MH	15	3.5 (1.4)	14	3.7 (1.3)	14	7.4 (2.0)	15	.67 (.62)	15	.73 (.80)	14	1.5 (1.1)
Dep-R	10	3.8 (1.5)	13	3.5 (1.7)	10	7.3 (1.8)	14	.50 (.76)	11	.36 (.67)	10	.90 (.99)
Dep-C	18	4.5 (1.4)	17	4.5 (1.4)	16	9.1 (2.1)	18	1.28 (.69)	17	1.24 (.75)	17	2.5 (1.1)
Total	113	3.4 (1.5)	114	3.4 (1.5)	104	6.8 (2.6)	120	.58 (.72)	111	.48 (.67)	97	1.1 (1.2)

Note. T1 = early pregnancy; T2 = late pregnancy; Both = the sum of the scores in T1 and T2.

^aT1 stress: $n=81$ missing; ^bT2 stress: $n=80$ missing; ^cBoth: $n=90$ missing; ^dT1 PHQ: $n=74$ missing;

^eT2 PHQ: $n=83$ missing; ^fPHQ Both: $n=97$ missing, MH = mental health other, Dep-R= depression in remission, Dep-C = depression current..

In the literature, stress appears to be more strongly related to cravings than depression. Cravings are higher in women whose cognitive controls of eating are undermined by negative emotions or who are emotional eaters when stressed (Macht, 2008). It is unclear whether depression is related to cravings. For some women, depression actively suppresses the appetite and women can lose weight (Uher et al., 2014). Other women have the opposite effect and depression can trigger cravings, emotional or external eating, and weight gain (Blaine, 2008; Ouwens et al., 2009). On the whole, intense emotion tends to inhibit intake (Macht, 2008). Therefore, it may be that less acute forms of stress, not depression, may be more consistently related to cravings. Creating this tier of mental health categories was the first step needed to examine this possibility.

Next, the means of the total number of cravings was calculated for each of the mental health categories. As can be seen in Table 15, women in the categories of MH other, depression in remission, and active depression had higher mean numbers of cravings than women without any mental health concerns. When collapsed into two separate groups, women with no mental health concerns ($n=135$) had

significantly fewer cravings than those with emotional distress (as measured by a composite of those in the MH Other, remission, or active depression categories, $n = 59$). Women with no mental health concerns had on average of 2.7 ($SD = 1.8$) cravings compared to 3.4 ($SD = 2.1$) cravings for those with emotional distress, $t = -2.356$ (192), $p = .019$.

Table 15

Mean Number of Cravings by Mental Health Category, $N = 194$

Category	N	M (SD)
No MH concerns	135	2.7 (1.8)
MH Other	15	3.2 (2.4)
Depression, remission	19	3.5 (2.1)
Depression, current	25	3.4 (2.1)

Note. MH = mental health; MH Other = stress, concrete services, domestic violence, anxiety.

While emotional distress is significantly associated with the number of cravings, other mental health constructs might be equally or more important. When running multiple regressions, the goal is to find the fewest number of independent variables that can predict the outcome. Therefore, a correlation matrix was run between numbers of cravings in pregnancy and each of the mental health variables. Three different variables were created for stress and three different similar versions were created for depressive symptomatology. Both the stress item ('able to handle stress') and the depressive symptomatology items (PHQ-2) are included in the MWS, which is completed twice in pregnancy. Therefore, the measures for stress include stress in early pregnancy from the MWS 1, stress in late pregnancy from the MWS 2, and a sum of the stress on the MWS 1 and MWS 2, which reflects stress across pregnancy. Similar variables were created to reflect depressive symptomatology using the PHQ-2.

Prior to running a correlation matrix, the characteristics of the variable 'total number of cravings in pregnancy' was examined to determine normality. The Z_{skewness} was 4.25 and the Z_{kurtosis} was 2.16 for the variable, total number of cravings in pregnancy. Both of these values were above a Z score of ± 1.96 above the mean of zero, indicating non-normality. The distribution of the variable, total number of cravings, was confirmed as having a non-normal distribution because the Kolmogorov-Smirnov test was

significant ($D(194) = .162, p < .001$). One of the assumptions of using a Pearson correlation is that the variables are normally distributed. Because this was not the case, a correlation matrix was created using Kendall's Tau-b. Kendall's Tau-b is recommended when the data set is small and has a large number of tied ranks (Field, 2009). The results of the bivariate Kendall Tau-b correlation matrix are displayed below in Table 16.

Table 16

Correlations Between Numbers of Cravings and Mental Health Variables

Variables	No. Cravings	MH	T1 Stress	T2 Stress	T1+T2 Stress	T1 PHQ	T2 PHQ
MH	.120*						
T1 Stress	.023	.274**					
T2 Stress	.170*	.288**	.408**				
T1 + T2 Stress	.117	.334**	.749**	.756**			
T1 PHQ	.003	.341**	.369**	.253**	.378**		
T2 PHQ	.058	.413**	.179**	.333**	.307**	.337**	
T1 + T2 PHQ	.029	.465**	.342**	.355**	.416**	.773**	.742**

Note. No. cravings = number of craving; MH = mental health categories none vs any; T1 Stress = stress scale completed on MWS 1; T2 Stress = stress scale completed on MWS 2; T1+T2 stress = sum of stress on T1 and T2 MWS; T1 PHQ = PHQ completed on MWS 1; T2 PHQ = PHQ completed on MWS 2; T1 + T2 PHQ = sum of results of PHQ from MWS 1 and MWS 2.

* $p < .05$ (two tailed) ** $p < .001$ (two tailed)

Both stress and a composite measure of emotional distress were significantly positively correlated with the numbers of cravings women reported in pregnancy. Having emotional distress (as measured by a composite measure of a clinician's assessment of a woman having past or current depression or current other mental health concern) was associated with women reporting a greater number of cravings. Higher stress in late pregnancy, but not at other times of pregnancy, was positively correlated to more cravings. Depression as measured by the PHQ-2 was not correlated with the numbers of cravings in pregnancy.

Late pregnancy stress and emotional distress (as measured by the composite of mental health categories) were significantly correlated with each other, but do not represent the same construct. This is evident because their correlations showed a moderate association (.288), but their correlation was less than .80. Multicollinearity is a concern if correlations of .80 or more are present between two variables

(Field, 2009). The bivariate Kendall's Tau-b correlation was well below this level of concern. Therefore both of these variables were used in multiple regression analysis as possible factors that could predict the number of cravings women report in pregnancy.

Smoking. Few women in the sample smoked; 15.5 % of women were smokers who smoked on average 9 cigarettes ($SD = 6.2$) at the beginning of their pregnancy. Data on whether women reduced smoking in pregnancy was available for 25 out of the 30 smokers. On average, women reduced the number of cigarettes they smoked by 94.1% ($SD = 10.7$). A bivariate Kendall's Tau-b correlation matrix was run with the smoking variables and the number of cravings in pregnancy and is displayed in Table 17. No significant correlations were seen between smoking and cravings. Therefore, no smoking variables were entered into multiple regression analyses.

Table 17

Correlations Between Smoking Variables and Numbers of Cravings in Pregnancy

Variables	No. Cravings	% Decrease
Smoking, yes	.064	
No. cigarettes smoked before pregnancy	.054	-.497*
% decrease in numbers of cigarettes smoked	-.034	1

Note. No. craving = number of cravings; No. cigarettes = number of cigarettes.

* $p < .01$

BMI Category. Overweight and obese non-pregnant women are more likely to report experiencing cravings (Burton et al., 2007; Davis et al., 2007). Overweight and obese women tend to be older and to have more children. Therefore, these variables, rather than weight, may be the salient construct and be associated with having more cravings. Therefore, a Kendall's correlation matrix with age, parity, BMI, and BMI category was created to assess the relationship between these variables and the numbers of cravings in pregnancy. Results are displayed in Table 18. Only age was significantly correlated with the numbers of cravings in pregnancy. As age increased, the numbers of cravings that women report decreased.

Table 18

Correlations Between Number of Cravings and Age, Weight, and Parity

Variables	No. Cravings	BMI	BMI Cat	Age	Parity
BMI	-.053				
BMI Category	-.087	.681**			
Age	-.163**	.174**	.245**		
Parity	-.036	.189**	.240**	.471**	
Parity Category	-.006	-.186**	.231**	.450**	.791**

Note. No. cravings = number of cravings; BMI cat = underweight/normal weight (coded as 1) vs. overweight/obese (coded as 2); Parity category = primiparous (coded as 0) vs. multiparous (coded as 1).
** $p < .01$

Summary. In summary, the numbers of cravings in pregnancy appears to be higher among younger aged women and those with stress in late pregnancy or emotional distress, as measured by having current or past depression or another mental health concern. Because this is an exploratory study, several different measures of depression, stress, smoking, BMI, and parity were included in the correlation matrices to determine which definition might be most likely to capture any potential relationships between possible predictors and numbers of cravings. Only age, stress in late pregnancy, and a composite measure of emotional distress were significantly correlated with the total numbers of cravings women reported in pregnancy. These three variables were entered into a multiple regression model to test whether the independent variables of stress in late pregnancy, emotional distress, or age were predictive of having a greater number of cravings in pregnancy.

Analysis and Results for Research Question 4: What Factors are Predictive of Reporting a Greater Number of Cravings in Pregnancy?’

Exploratory Analysis. Prior to running multiple regressions, an exploratory analysis was conducted for the dependent variable, total number of cravings in pregnancy. Tests for normality indicated that the variable, numbers of cravings in pregnancy, did not have a normal distribution as discussed above (page 105). The presence of outliers can create a non-normal distribution. Two univariate outliers were noted on median boxplots of the dependent variable, numbers of cravings in pregnancy. Because the assumption of concern in multiple regressions is that there is a normal distribution of errors,

not that the dependent variable is normally distributed, these outliers were kept in the sample during the initial analysis of the data.

Multiple regressions were conducted using stepwise entry with age, stress in late pregnancy, and emotional distress as the independent variables and the numbers of cravings as the dependent variable. Listwise comparisons exclude variables without information of all variables; this dropped the sample size to 114 subjects. Experts differ in their recommendations about what an appropriate sample size should be, particularly in exploratory research where effect sizes are unknown. However, with three independent variables, $\alpha = .05$ and $\beta = .80$, and a medium effect size, Field suggests using the formula $N \geq 50 + (8 \times \text{number of predictors})$ to test the regression model and $N \geq 104 + \text{numbers of predictors}$ to test the unique contribution of the predictors (Field, 2009). The higher number of the two calculations should be chosen as the minimum sample size. This calculations result in a sample size of 74 cases or 107 cases, respectively. Thus, the minimum sample size needed to run multiple regressions is 107.

Testing of Assumptions. Next, an examination was conducted to determine if the data met the assumptions of multiple regressions. The assumption of the independence of errors was met as the Durbin Watson test was 2.153, which met the recommended value of approximately 2. There are also no concerns about multicollinearity as the VIF values of 1.01 are well below 10, the tolerance levels (.988) were well above the danger zone of 0.1 to 0.2., and the variance proportions are scattered appropriately across the dimensions in the Collinearity Diagnostic Table. Homoscedasticity, which looks at the variance of the residuals, was evaluated by examining the plots of ZRESID vs. ZPRED and SRESIS vs. ZPRED. No funneling was noted. The assumption of Normality of Errors appears to be met based on an examination of the histogram of the standardized residuals and P-P plots, which shows a normal distribution; although it appears that there are some multivariate outliers.

Next, an examination of the data was conducted to look for outliers and influential cases. Cooks distances are less than 1 (maximum value of .123), indicating that there is not undue influence from a particular case. The critical value for Mahalanobis distance, which calculates the distance of each case

from the centroid of all cases, is dependent on the number of independent variables and the desired alpha level (Tabachnik & Fidell, 2007). In this analysis, the maximum value on the Mahalanobis distance of 8.824 is less than the critical value of 16.266 obtained by consulting a table of Critical Values for Chi Square (χ^2 for three independent variables with an α of 0.001 is 16.266) ("Table C.4 Critical values of Chi-Square," 2007).

However, the presence of outliers was noted on examination of leverage and of the standardized residuals. Leverage appears to be a problem for one case (subject 1320) with a leverage value of .078, which is above the maximum acceptable leverage value. (Average leverage values are calculated by the formula $k + 1/n$, where k is the number of predictor and n is the sample size. The maximum allowable limit is two times greater than the average and in this case is .070.) Because this extremely high value can significantly influence regression coefficients, this case was dropped from the analysis. An examination of the standardized residuals (SR) indicated that two cases were above 3. One case (subject 1242) with a SR of 3.19 was already identified as a case of concern in the examination of univariate outliers. The other case identified earlier as being a univariate outlier had incomplete information on stress and was dropped from the regression analysis. One additional case was identified as being of concern (subject 1280) with a SR of 3.0448. A total of 3 cases were dropped, leaving a sample size of 111, two for high standardized residuals and one for having a high leverage value.

After deleting the two cases with high standardized residuals and the one with high leverage, multiple regressions were run again and the sample size for the analysis of Research Question 4 dropped to 111. With three predictors, this sample size remains sufficient to detect a medium effect size.

Results of Final Regression Model. Multiple regressions were run with the sample with outliers deleted ($n = 111$) using stepwise entry to determine the relative contribution of each predictor to the model. Assumptions were reexamined on the sample with outliers deleted ($n = 111$). No violation of the assumptions of Independence of Errors was present as evidenced by a Durbin-Watson statistic of 1.815. No multicollinearity was seen as the variance proportions were appropriately dispersed across the

dimensions in the Collinearity Diagnostics Table, tolerance levels were well above 0.01 (values in this analysis were .997) and VIF levels were below 10 (values in this analysis were 1.003). Normal distribution of errors was evident by the normal distribution of the histogram and the close alignment of the residuals with the line on P-P Plots of the standardized residuals. Heteroscedasticity, which is the assumption that variance of the residuals is homogenous across all levels of the predicted values, is tested by an examination of the standardized residuals against their predicted values. The resultant scatterplots should form a 'cloud' with no directionality noted. No heteroscedasticity was noted on examination of the scatterplot. No outliers of concern were found after examining Mahalanobis distance; the value of 5.523 is less than the critical value of 16.266 ("Table C.4 Critical values of Chi-Square," 2007). The maximum value of Cook's distances is .102, which is less than the value of concern of 1. Maximum leverage value is .050, which is below the level of concern of .072 ($[3 \text{ predictors} + 1/n=111] \times 2 = .072$). No cases have standardized residuals above 3. Three cases or 2.7% of the 111 cases have values above 2. Field (2009) suggests that up to 5% of the sample can have standardized residual values of 2 or more without compromising the integrity of the results. Thus, the final model meets the assumptions necessary to conduct multiple regression analyses.

The final model used the sample with outliers removed ($n = 111$). Multiple regressions using stepwise entry were run with stress in late pregnancy, emotional distress, and age as independent variables and the numbers of total cravings reported in pregnancy as the dependent variable. The model including age only was significant, $F(1,109) = 5.33, p = .023$, as was the model including both age and stress, $F(2,108) = 5.143, p = .007$. The third independent variable, the composite measure of emotional distress, fell out of the final model.

The results of the regressions indicate that two predictors-- age and stress in late pregnancy-- accounted for 8.7% of the variance in the numbers of cravings reported in pregnancy ($R^2 = .087, R^2_{\text{adjusted}} = .070, F(2, 108) = 5.14, p = .007$). Both age and stress predicted the number of cravings reported in pregnancy, but in opposite directions. Younger age was associated with a greater number of cravings, $\beta =$

-.205, $t(110) = -2.222, p = .028$. Higher stress was associated with a greater number of cravings, $\beta = .201$, $t(110) = 2.184, p = .031$. In the first step, age accounted for 4.7% of the variance in the numbers of cravings in pregnancy. Adding stress to the model improved the ability of the model to account for the variance in the numbers of cravings by 4.0%.

Results are displayed in the Table 19 below. This table includes the correlations between the variables, descriptives of the variables, and the unstandardized (B) and standardized regression coefficients (β) of the regression models.

Table 19

Regression Models of Predictors of the Number of Cravings Reported in Pregnancy

Multiple Regression Results										
Variables	No. Cravings	Age	ED	Stress	Model 1 Age Only			Model 2 Age and Stress		
	Correlations				B	SE B	β	B	SE B	β
Age	-.216*				-.074	.032	-.216*	-.070	.032	-.205*
ED	.095	-.107								
T2 Stress	.213*	-.056	.315	1			.245	.112	.201*	
	Descriptives					R² change=.047		R² change=.040		
<i>M</i>	2.8	27.0		3.4	<i>F</i> (1,109) = 5.333*		<i>F</i> (2,108) = 5.143**			
<i>SD</i>	1.8	5.3		1.5						

Note. No. Cravings = number of cravings; ED = emotional distress; T2 Stress = Stress in late pregnancy; *M* = mean; *SD* = standard deviation.

* $p \leq .05$ ** $p \leq .01$

Summary. Women with greater numbers of cravings appear to be younger and more stressed. However these two predictors account for a small proportion of the variance (8.7%) in the numbers of cravings women report in pregnancy.

Conclusion

Over 90% of women report having cravings at some point in pregnancy. Cravings for fruits and vegetables are the most commonly reported cravings with one-third of women in the sample reporting cravings for fruits and vegetables in both early and late pregnancy. Cravings for less healthy foods are less common. For example, 16% of women in this study reported cravings for sweets throughout

pregnancy. Cravings were not associated with prenatal weight gain. Having higher stress in late pregnancy and being younger were predictive of reporting a greater number of cravings in pregnancy. The strength of these findings is undermined by the small sample size in this study.

CHAPTER 5

This chapter will first address the findings of each research question in relation to what has been reported in the literature and then discuss the limitations of the study, concluding with a discussion on the implications of the study for clinical care and future research.

Discussion

The three areas addressed by this research study were: (1) prevalence of cravings in pregnancy, (2) associations between cravings and prenatal weight gain, and (3) predictors of the numbers of cravings reported in pregnancy.

Prevalence of Cravings

As has been reported in other studies, cravings in pregnancy are almost universal. Over 90% of women experienced at least one craving in this study, compared to 76% (Tierson et al., 1985), 80% (Belzer et al., 2010) and 86% (Pope et al., 1992) in prospective cohort studies conducted in the United States. In this study, the two most common types of cravings were for fruits/vegetables and sweets. The frequency of cravings for protein, starches, and salty foods were lower than those reported for fruits/vegetables and sweets, but were similar to each other, making up a third tier of the most frequently reported cravings. Other studies have reported similar findings. Fruits/fruit juices and sweets are consistently reported as being the most common cravings (Fairburn et al., 1992; Finely et al., 1985; Hook, 1978; Tepper & Seldner, 1999; Tierson et al., 1985). Cravings for other foods (i.e., protein, starches, and savory foods), while reported, appear to be less frequent (Fairburn et al., 1992; Finely et al., 1985; Pope et al., 1992; Tepper & Seldner, 1999).

Unlike other studies reported in the literature, cravings in this study as a whole tended to persist over time with 75.3% of women in early pregnancy and 81.4% of women in late pregnancy reporting having at least one craving. Only three other prospective cohort studies have documented craving prevalence across pregnancy, all three reported that cravings began before the 16th week of pregnancy and declined over the course of the pregnancy (Belzer et al., 2010; Fairburn et al., 1992; Tierson et al., 1985).

The most rigorous of these is the one by Belzer et al. (2010), as unlike any of the other prospective studies, including this one; the authors reported on the prevalence of cravings in late pregnancy. On average, the last measurement period in this study occurred at 31 weeks of pregnancy and at 30 weeks in the study by Fairburn et al., 1992. Tierson et al. (1985) reported on the prevalence and timing of onset and remission of cravings for 70 food items, making it difficult to make comparisons to this and other studies. Further, Belzer et al. (2010) used a more rigorous definition of cravings, asking about cravings which occurred over the prior week as opposed to over the last month in this study. Belzer et al. (2010) reported that the prevalence of reporting any cravings among healthy pregnant women ($n = 93$) fell significantly across time with 81% reporting cravings between 16 and 20 weeks of pregnancy, 68.8% between 24 and 28 weeks of pregnancy, and 57.4% between 34 and 38 weeks of pregnancy, $F(3, 249) = 6.32, p = .0004$ (Belzer et al., 2010).

Of the three prospective studies describing the prevalence of cravings, only one categorized cravings into specific food groups (Belzer et al., 2010). Belzer et al. (2010) categorized cravings into six categories: sweets, salty, savory, starchy, non-sweet dairy, and other. These categories are similar to the ones used in this study with two major exceptions. First, Belzer et al. (2010) included fruit and juice in their sweet category. In this study, fruits and juice were categorized along with vegetables into a fruit/vegetable group. Sweets in this study were a separate group. Second, the savory craving group in the study by Belzer et al. (2010) included eggs, meat, and seafood, making it similar to the protein category used in this study. However, the savory group in the Belzer et al. (2010) study also included sandwiches, pizza, and French fries. These latter foods were included in the 'Other' category in this study. Belzer et al. (2010) only reported on their results for two categories: sweets and savory.

While not directly comparable due to differences in the ways that the craving categories were defined, there are similarities between the study by Belzer et al. (2010) and this study. In the study by Belzer et al. (2010), the prevalence of cravings for savory items declined steadily across pregnancy dropping from 47% at 16 to 20 weeks of pregnancy to 27.5% at 24 to 28 weeks to 20.9% at 34 to 38

weeks, whereas in this study, cravings for protein was lower and relatively stable across time with 17% reporting cravings for protein in early pregnancy and 21% in late pregnancy. The prevalence of sweet cravings in the study by Beltzer et al. (2010) was 44% at 16 to 20 weeks of pregnancy, peaked at 54% between 24 and 28 weeks and then declining to 45.6% at 34 to 38 weeks of pregnancy (Belzer et al., 2010). Like in the study by Belzer et al. (2010), cravings for sweets were more prevalent early in the third trimester relative to other time periods; in this study, the prevalence of women reporting sweet cravings rose from 24.2% in early pregnancy to 36.2% in late pregnancy.

In summary, cravings are universal. Most studies report that their prevalence declines over the course of pregnancy. Sweets are among the most commonly reported cravings in the literature and, compared to early pregnancy, appear to increase in prevalence in late pregnancy. Given the limitations of this study and others conducted to date, the relationships between sweet cravings and prenatal weight gain is under explored and should be investigated in future studies.

Cravings and Weight Gain

The hypothesis that persistent cravings, which occur in early and late pregnancy, would be associated with greater weight gain was not proven in this study. Neither craving in general or within food groups were associated with statistically significantly higher weight gain in women with persistent cravings compared to women reporting transient or no cravings. A review of the descriptive data suggested that persistent cravings for starches in late pregnancy might be of concern. Persistent cravings for starchy food, was associated with the greatest weight-gain ratio of all the food craving categories. However, no differences were seen in the mean weight-gain ratios between women reporting craving starches only in early pregnancy, only in late pregnancy, or in both time periods, $F(2, 64) = 2.54, p = .087, w = .209$.

One of the reasons that there may not be statistical significances in prenatal weight gain among the craving groups is that the sample size in this study was too small. This premise is supported by the wide confidence intervals surrounding prenatal weight gain. For example, only 12 subjects reported

having persistent cravings for starches, their weight-gain ratio was 1.47 with a confidence interval of .70. Such few numbers makes it difficult to detect statistically significant differences in the amount of weight gained.

The literature, while sparse, suggests that the relationship between cravings and prenatal weight gain is worthy of further investigation. To date, only three studies have been published which examined the relationships between dietary cravings and dietary intake in pregnancy. Two reported either significantly greater intakes of food (Tierson et al., 1985) or higher intakes of fats, sugars, or calories (Pope et al., 1992) in women with cravings compared to women without cravings; the third found no significant correlations between sweet cravings and intakes of sweet food (Belzer et al., 2010). Two studies have investigated the relationship between cravings and prenatal weight gain. Both reported that cravings were associated with higher prenatal weight gain (Allison et al., 2012; Hill & McCance, 2014). However, the quality of these studies was poor or unknown. Therefore, additional research is needed with sufficient sample size and using a more comprehensive definition of cravings than that used to date. Only after better designed studies are conducted can it be determined if there is or is not a relationship between cravings and prenatal weight gain.

Predictors of the Numbers of Cravings

Having multiple cravings is common. The average number of cravings in this study was 3.2 (*SD* = 1.8) among women who reported having any cravings. This is similar to other studies that have reported that women craved an average of 1.8 (Dickens & Trethowan, 1971), 3.7, (Worthington-Roberts et al., 1989) and 4.04 (Crystal et al., 1999) food items in pregnancy.

The following section will discuss the predictors investigated in this study (smoking, stress/depression, and age/obesity) in relation to what has been reported in the literature to date.

Smoking. Only two studies have investigated the relationships between smoking and cravings in pregnant women. In a retrospective cross-sectional study of primiparous women ($n = 100$), Dickens and Trethowan (1971) reported that women with cravings were significantly more likely to smoke cigarettes

compared to non-smokers, $\chi^2 = 4.966$, $n = 1$, $p < .05$. Adegboye et al. (2010) found that women who recently quit smoking cigarettes ($n = 390$) had higher rates of experiencing cravings (58.7%) than women who continued to smoke cigarettes (53.6%, $n = 290$) and those who never smoked (50.6%, $n = 1,159$), although these differences did not reach statistical significance.

In this study, there was no significant correlation between the numbers of craving a woman reported in pregnancy and the numbers of cigarettes a woman smoked before pregnancy or in the percentage her consumption decreased in pregnancy. No significant differences were seen in the mean number of craving in smokers ($M = 3.3$, $SD = 2.3$, $n = 30$) compared to non-smokers ($M = 2.8$, $SD = 1.9$, $n = 164$), $t(192) = .151$. Of the 25 smokers for which there were data on the amount they smoked in pregnancy, no differences were seen in the numbers of cravings reported by women who continued to smoke ($M = 4.4$, $SD = 2.7$, $n = 8$) and those that quit ($M = 3.5$, $SD = 2.0$, $n = 17$), $t(23) = .878$, $p = .389$.

While the associations between cravings and smoking were statistically significant only in one study (Dickens & Trethowan, 1971), similar patterns were noted in smokers compared to non-smokers in all three studies. In this study, as well as the one by Dickens and Trethowan (1971) and the one by Adegboye et al. (2010), cravings were slightly more common or greater in number in smokers compared to non-smokers. Since cravings appear to affect smokers more than non-smokers, but only to a small degree, it may be that subpopulations of smokers, such as those who are younger or more stressed, may have more difficulty effectively managing food cravings than smokers as a whole. No work has yet been done in this area.

Stress and Depression. In this study, stress, but not depression, was significantly correlated with the numbers of cravings women reported in pregnancy. Stress in late pregnancy accounted for a small, but significant, variation in the numbers of cravings a women reported in pregnancy. The results of this study are supported by the only other study addressing the relationships between stress and cravings in pregnant women. In a cross-sectional study of primiparous postpartum women ($N = 100$), Dickens and Trethowan (1971) reported that pregnant women whose appetite was affected by emotional stress were more likely to

report cravings than those whose appetite was not affected by stress, $\chi^2 = 8.039$, $n = 1$, $p < .005$. Dietary cravings have also been reported to be higher in non-pregnant women who regulate negative emotions through consuming palatable foods (Franken & Muris, 2005; Macht, 2008).

Higher stress has consistently been found to be related to unhealthy dietary intake in pregnant women (Fowles, Bryant, et al., 2011; Hurley et al., 2005; Lobel et al., 2008). Stress-related eating is also associated in non-pregnant women with greater consumption of sweets, soda, and alcohol (Jaaskelainen et al., 2014), greater waist circumference and higher rates of prediabetes (Tsenkova, Boylan, & Ryff, 2013), and being overweight or obese in longitudinal cohort studies (De Vriendt et al., 2012; Jaaskelainen et al., 2014).

Whether stress or depression is related in prenatal weight gain is unclear. Only a few studies have investigated the relationships between stress and depression and prenatal weight gain. Higher stress has been reported to be unrelated to weight gain (Chasan-Taber et al., 2008; Sangi-Haghpeykar, Lam, & Raine, 2014; Wells et al., 2006) or related to gaining too little (Webb et al., 2009; Zhu et al., 2013). Depression has been found to be related to weight gain in unadjusted models, but unrelated to weight gain in models that controlled for confounding variables such as age, BMI, and parity (Sangi-Haghpeykar et al., 2014; Webb et al., 2009; Wright et al., 2013). In this study, stress in early, but not late pregnancy, had a small negative correlation with the prenatal weight-gain ratio, Kendall tau correlation = $-.141$, $p = .042$, $n = 113$, indicating that as stress increased in early pregnancy, women gained less weight.

In total, the finding of this study, and others in the field, suggest that stress is related to dietary cravings in both pregnant and non-pregnant women. In turn, studies published to date support the premise that stress is related to unhealthy dietary intake. The evidence on the relationships between stress and depression and prenatal weight gain is limited, but, in total, the evidence suggests that emotional factors have little relationship, or even a negative relationship, with prenatal weight gain. However, more research is needed before any firm conclusions can be drawn.

In non-pregnant individuals, research findings indicate that the relationships between emotions and food intake is very complex and dependent on the underlying cognitive and emotional response that any particular individual has in relationship to food (Macht, 2008; Ouwens et al., 2009). For example, individuals under low-level stress have been found to increase their food intake while those under extreme stress may decrease their intake (Macht, 2008).

Because longitudinal studies in non-pregnant individuals have reported relationships between stress, unhealthy dietary intake, and adiposity, it is possible that stress and depression do in fact influence prenatal weight gain, but the research conducted to date has not been designed to capture these relationships. For example, the instruments used to measure stress so far may not be appropriate. Pregnancy anxiety, as opposed to general anxiety or stress, is more strongly linked to preterm birth and adverse prenatal outcomes than to general anxiety, depression, or stress (Ding et al., 2014; Dunkel Schetter & Tanner, 2012). Pregnancy stress, anxiety, and depression also seem to impact the fetus differently, with anxiety most strongly related to preterm birth and depression more strongly related to low birth weight (Dunkel Schetter & Tanner, 2012). Further, the timing in which stress occurs may also matter. In the only study yet published on the relationship between the timing of stress and gestational weight gain, Zhu et al. (2013) found that there was a dose-response effect of stress on prenatal weight gain. For each unit increase in the numbers of stressful events reported in the first trimester of pregnancy, there was a corresponding reduction in gestational weight gain of 0.497 kg, 95% CI, [0.176, 0.817]. This relationship was not seen for stress occurring in the second or third trimester of pregnancy. In addition, the relationship between greater stress and lower prenatal weight gain was seen only in underweight and normal weight women, not in overweight or obese women. Therefore, further research is needed to elucidate the relationships between stress, depression, cravings, dietary intake and prenatal weight gain. Careful attention should be given to the choice of instruments and populations to be studied. Use of a prospective design could help determine whether there are more vulnerable periods in pregnancy in which stress or depression has the greatest impact on dietary intake and weight gain.

Age and Obesity. Obese women are more likely to be emotional eaters (Geliebter & Aversa, 2003), who are in turn more likely to experience cravings (Burton et al., 2007). Therefore, it was hypothesized that obese women would have a greater number of cravings. However, because age, parity, and BMI are all interrelated, a correlation matrix was run to determine which of these factors were related to the numbers of cravings women reported in pregnancy. Maternal weight, whether described by BMI as a continuous or categorical variable, was not related to the numbers of cravings women reported in pregnancy. Only younger age was significantly correlated with having a greater number of cravings.

The strongest study linking cravings to unhealthy dietary intake was conducted in young adolescents whose mean age was 16 years ($N = 97$) (Pope et al., 1992). Pope, Skinner, and Carruth (1992) interviewed women every two weeks in the last three months of pregnancy and obtained 24 hour dietary recalls and diet records. Women with cravings for sweets had significantly higher calorie and sugar intake and women with cravings for salty snacks had significantly higher intakes of salt and fat than women without these cravings (Pope et al., 1992). Because this study only included women 18 years of age or older, no direct comparison can be made with the study by Pope, Skinner, and Carruth (1992). However, as can be seen in Table 20, the mean number of cravings dropped as women aged, but this drop plateaued at approximately 25 years of age. Therefore, it may be that cravings are a more common feature in pregnancy in adolescent women and/or women in their early 20s. If this is the case, cravings may be not be a reflection of stress-induced or disordered eating but a physiologic response to women who have not finishing growing themselves.

Table 20

Numbers of Reported Cravings by Age Category, N = 194

Age Category	Number of Cravings	
Years	N	M (SD)
18 to 20	27	3.4 (2.2)
21 to 24	52	3.2 (1.8)
25 to 29	59	2.6 (1.9)
30 to 34	44	2.7 (2.0)
≥ 35	12	2.0 (1.3)

Limitations

The major limitation of this study is that it was a retrospective chart review study using a convenience sample with a small sample size. The second major limitation is related to the definition used to describe cravings. Both of these problems significantly undermine the quality, validity, and generalizability of the study results.

Quality

Several problems affected the quality of this study: incomplete data, loss of subjects due to attrition, and the way the sample was selected. Because this study analyzed retrospective data collected during the course of routine clinical care, it was not possible to monitor the quality and completeness of data in real time and correct issues as they arose. Many patients entered care too late or left care too early, making it impossible to collect data within the time parameters needed to calculate cravings frequencies and weight gain. Further, because this data was collected as part of clinical care, the questionnaire was adapted over time. In particular, data on depressive and stress symptoms were missing for a large subset of the sample; these questions were added to the later versions of the MWS. Out of the 814 women eligible to be included in this study, 620 were excluded from the sample due to incomplete data, and 194 were retained in the sample. So few patients had enough complete data that it was not possible to randomly select among patients with complete data, which is a technique that could have minimized the impact of selection bias.

One way to determine if selection bias is present is to compare those included and those excluded due to incomplete data by looking at the key characteristics that might influence outcomes. The principle question in this study was whether dietary cravings were related to prenatal weight gain. The most powerful predictor of prenatal weight gain reported in the literature is BMI (Chu et al., 2009; Herring et al., 2012; Weisman, Hillemeier, Symons Downs, Chuang, & Dyer, 2010). No differences were seen in BMI between those included in the sample and those excluded due to incomplete data. Being nulliparous and of younger age have also been cited as predictors of higher prenatal weight gain (Chu et al., 2009; Herring et al., 2012). No differences were seen in parity. No significant differences were seen in the percentage of adolescent women ≤ 21 years of age between those included and excluded in the sample, although those included were significantly older by one year. Compared to women included in the sample, women who were excluded had significantly higher rates of smoking and less reduction in the numbers of cigarettes they smoked in pregnancy. Compared to non-smokers, women who continue to smoke have been found to have lower prenatal weight gain and smokers who quit have higher prenatal weight gain compared to never-smokers. (Adegboye et al., 2010; Rodrigues et al., 2010)

Validity

Statistical validity was adversely affected by the sample size. The small sample size resulted in a loss of power. For example, cell sizes were very small, particularly for cravings that were reported to occur in early as well as late pregnancy. Only 12 women reported persistent starch cravings, 16 reported persistent salty cravings, 19 reported persistent protein cravings, and 32 reported persistent sweet cravings, making it difficult to determine if there was an association between persistent cravings and prenatal weight gain. This was particularly problematic for those reporting persistent cravings for starchy foods, since the association with higher weight gain approached statistical significance. Cell sizes were also small in subsets of the sample, such as in underweight women ($n = 7$) and smokers ($n = 30$). In this study, 100% of underweight women reported having at least one craving in pregnancy compared to 91.7% of the sample as a whole. Smokers had a higher number of cravings than non-smokers, although

no statistically significant differences were noted. Having a small sample size made it difficult to explore associations between cravings and prenatal weight in potentially higher-risk individuals. In addition, statistical validity was also compromised by the choice of the PHQ-2 to measure depressive symptomatology. The PHQ-2 had response options that had a limited range from 0 to 2, which may have made it more difficult to tease out relationships between depression and dietary cravings. In contrast, because the stress scale has a response range of 0 to 6, its structure may have made it easier to identify relationships between dietary cravings and stress.

Construct validity was compromised by the definition of cravings used in this study. In this study, the definition of cravings was based only on the presence or absence of cravings in various food groups. No questions were asked about the strength of these cravings or how frequently women indulged their cravings. The assumption was made that women who reported cravings would consume a greater amount of craved foods and by doing so gain a greater amount of weight. Only one study was found that reported first on the presence of cravings and then asked a follow-up question about consumption of craved food items in pregnant women. In this prospective cohort study of pregnant Ecuadorian women ($n = 849$), 95% of those who reported experiencing particular food cravings also consumed those food items (Weigel et al., 2011).

Each of the three prospective studies on the relationships between cravings and dietary intake in pregnant women residing in the United States used different definitions of cravings. Tierson, Olson, and Hook (1985) defined cravings as ‘strong likings’ for specific foods that lasted more than 24 hours, whether the foods were consumed or not. Craved food items were then collapsed into 70 food groups for ease of reporting. Foods could be double coded so that, for example, cravings for ‘chocolate especially chocolate ice cream’ would be coded into four categories: chocolate milk, chocolate ice cream, chocolate, and chocolate ‘other’. Pope, Skinner and Carruth (1992) did not describe how cravings were defined in their study. Belzer (2010) did not define the word cravings, but did ask women to indicate if they experienced any cravings for foods in the week prior to being interviewed and, if so, to list the three most

common cravings and the frequency of these cravings in the prior week. Belzer (2010) did not ask specifically whether women indulged in those cravings, rather they administered a standardized food survey on 141 commonly consumed foods.

Both of the two studies investigating the relationships between cravings and prenatal weight gain measured cravings in different ways. Allison et al. (2012) did not define cravings per se, but asked specifically if eating due to cravings contributed to a woman's weight gain on a scale of 1 (not at all) to 5 (extremely). Higher scores on this measure were associated with greater prenatal weight gain (Allison et al., 2012). The other study on cravings and prenatal weight gain has not yet been published in a peer-reviewed journal, so the definition of cravings used by Hill & McCance (2014) is unknown. Thus, none of the studies to date on cravings in pregnancy have used the same definition of cravings, making it difficult to determine the degree to which cravings impact dietary intake or prenatal weight gain.

Generalizability

The subjects included in this study were fairly homogenous. Few were underweight and the remainder of the sample was fairly evenly split between normal weight, overweight, and obese women. The sample was composed of primarily ethnic minority women with nearly two-thirds identifying themselves as being Hispanic and almost 80% identifying themselves as being Multi-Racial or African American. Most of the women included in the sample were low-income; almost all individuals receiving care in the urban community health center where the study was conducted received Medicaid or had no insurance. Thus, the results of this study reflect the experiences of low-income minority urban women and cannot be generalized to other populations.

Implications

The results of this study have implications both for clinical practice and for future research. Cravings can no longer be considered to be a benign and quirky symptom of pregnancy for all women. While the evidence is very preliminary, there is a possibility that cravings may be related to unhealthy dietary intake and higher prenatal weight gain. In an abstract published on-line, Hill (2014) reported that

women with cravings gained 1 kilogram more than women without cravings in a prospective cohort study of Irish women ($N = 1,639$). In a small study of overweight and obese African American women ($N = 120$), Allison, et al (2012) reported that prenatal weight gain increased as the influence of cravings became stronger. While the evidence is too preliminary to recommend universal screening for cravings in general care, practitioners caring for pregnant women should be aware of a potential relationship between cravings, poorer quality dietary intake, and higher prenatal weight gain.

The research in this field is very preliminary. Research in this area should next focus on developing a specific tool to measure cravings in pregnancy. Using different instruments to measure cravings makes it almost impossible to compare results. The impact of using different definitions of cravings is well illustrated in a study on the prevalence of cravings in non-pregnant adult women ($N = 101$). The prevalence of reported cravings in this study varied widely depending on whether the definition includes intensity and/or one or more of the core features of cravings. These core features are: (1) the extent to which someone can resist their cravings, (2) the anxiety an individual feels when they forego consuming a craved food item, and (3) the speed at which a craved food is consumed. Prevalence rates of reported cravings were 58% if the question asked was ‘Have you have ever had any cravings?’ Prevalence rates dropped if a modifier of intensity was added to the question, falling to 42% for cravings of moderate intensity to 21% for cravings of severe intensity to 4% when all three core features were present and cravings were of severe intensity (Gendall, Joyce, & Sullivan, 1997).

Further cravings are also reported by women with eating disorders (Cepeda-Benito, Fernandez, & Moreno, 2003; Ng & Davis, 2013). Women with binge-eating disorder or bulimia gain more weight in pregnancy than women with healthy eating patterns (Siega-Riz et al., 2011). Instruments measuring cravings have been developed for use in non-pregnant adults-- they include a component on craving intensity and can distinguish between individuals with or without an eating disorder (Cepeda-Benito et al., 2003; Cepeda-Benito, Gleaves, Williams, & Erath, 2000)-- but they are long and therefore not easily incorporated into clinical care. The original version of one of the most commonly used instruments, Food

Cravings Questionnaire-Trait: the FCQ-T, is composed of 39 items. Even the short version contains 15 items (Meule, Hermann, & Kübler, 2014). Both versions are too long to be useful in clinical care. Thus, developing a short yet comprehensive instrument composed of items reflecting the persistence, intensity, and indulgence of cravings, which also was the ability to detect the presence or absence of eating disorders, is necessary before assessing craving in clinical care in a systematic way would be warranted.

In addition, research is needed to identify those subpopulations at greater risk of experiencing intense and persistent cravings. Because cravings are a universal phenomenon in pregnancy, cravings are likely to be problematic only for a subset of women. Very little research has been conducted to date on predictors of cravings. Therefore, further research is needed to identify individuals at risk of experiencing intense-enough cravings that may be associated with unhealthy dietary intake or prenatal weight gain. This study suggests that younger women and those under higher stress may experience more cravings. Other potential populations of concern include those who smoke cigarettes or who are overweight or obese. Research should focus on whether cravings are problematic in these sub-groups.

Conclusion

Cravings are common in pregnancy. For most women, they are a transient phenomenon associated with no ill effects for themselves or their babies. However, they may be problematic for a minority of women. Two (Pope et al., 1992; Tierson et al., 1985) out of three studies (Belzer et al., 2010) in U.S. populations have found that pregnant women increase their intake of craved foods. Two studies have reported that cravings are related to higher prenatal weight gain (Allison et al., 2012; Hill & McCance, 2014).

This study found no significant relationship between cravings in general or by food group and prenatal weight gain. No significant differences were seen in prenatal weight gain based on when cravings occurred in pregnancy. However, the sample size in this study was too small to detect differences. Being younger was associated with greater numbers of cravings in this study. Stress was also associated with cravings in this study, as well as in a study by Dickens (1971). Other populations of that may also be

more likely to experience cravings are overweight or obese women and those that smoke cigarettes.

Further research is needed to better characterize cravings in pregnancy, to determine the extent to which they are associated with unhealthy dietary intake and weight gain, and to identify subpopulations at greatest risk of experiencing intense and persistent cravings

APPENDIX A:
MATERNAL WELLNESS SCREENER

Pregnancy Screener

CHART LABEL
HERE

We would like to know more about you and your pregnancy.
Thank you for your time!

Over the past month, the **AMOUNT** of food I usually eat is: **(Check one)**

- MORE than before I was pregnant Why _____
- SAME as before I was pregnant Why _____
- LESS than before I was pregnant Why _____

Do you eat more, the same or less of the following foods now than before you became pregnant?

(Circle one for each)

Milk, cheese	More	Same	Less	I don't eat that
Meat	More	Same	Less	I don't eat that
Fruits, vegetables	More	Same	Less	I don't eat that
Starchy foods (rice, bread, tortillas)	More	Same	Less	I don't eat that
Sweets	More	Same	Less	I don't eat that
Other _____	More	Same	Less	

Since I became pregnant, I have cravings for: **(Check all that apply)**

I-3

- | | |
|---|---|
| Sweets <input type="checkbox"/> | Fruits, vegetables <input type="checkbox"/> |
| Salty foods <input type="checkbox"/> | Ice <input type="checkbox"/> |
| Meat <input type="checkbox"/> | Other _____ <input type="checkbox"/> |
| Starchy foods (rice, bread, tortillas) <input type="checkbox"/> | None <input type="checkbox"/> |

Over the past month, my activity level is: **(Check one)**

- MORE than before I was pregnant Why _____
- SAME as before I was pregnant Why _____
- LESS than before I was pregnant Why _____

What is the total amount of weight you think you should gain during your pregnancy (from the time you became pregnant to the time you have your baby)?

pounds (lbs)

How would you rate your ability to *handle stress*? **(Circle a number from 1 to 6)**

I-6

I don't let things bother me						I get very stressed out about things
1	2	3	4	5	6	

CHART LABEL HERE

Here are some things that help women reduce stress. Circle how often you do each of the following in a usual week. **(Circle one answer for each)**

	Usually	Often	Sometimes	Never
a. Get enough sleep	1	2	3	4
b. Take some time for relaxation every day	1	2	3	4
c. Accept things in my life that I cannot change	1	2	3	4
d. Focus on pleasant thoughts at bedtime	1	2	3	4
e. Use specific methods to control my stress	1	2	3	4
f. Balance time between work and play	1	2	3	4
g. Practice relaxation, meditation, or prayer for 15-20 minutes each day	1	2	3	4
h. Pace myself to prevent tiredness	1	2	3	4

I-8

Over the past month I have been bothered by

- 1) Little interest or pleasure in doing things? Yes No
- 2) Feeling down, depressed, or hopeless? Yes No

Is there someone in your life who is hurting you, threatening you, or frightening you? Yes No

During the past week, on how many DAYS did you do moderate activity (physical activity that makes you feel warm, like walking fast, cleaning floors or windows, or dancing). _____ days in past week

On those days, how much time did you spend on average doing moderate activity? _____ minutes each day

I take calcium supplements **(Check one)**

Never _____ Sometimes _____ Every day _____

I drink juice that has calcium in it **(Check one)**

Never _____ Sometimes _____ Every day _____

When you eat **chicken**, is it usually fried? **(Check one)** Yes ___ No ___

When you drink **milk**, including the milk in your cereal or coffee, is it usually:

(Check one) Whole ___ 2% ___ 1% ___ Skim ___

When you eat **potatoes**, are they usually: **(Check one)**

Baked ___ Boiled ___ French fries ___

Food Frequency Screener

LABEL HERE

Think about what you eat and drink in a usual week. Write down the TOTAL number of times you have each type of food or drink EACH DAY. If you don't have it every day, write down the number of times you have it EACH WEEK. If you have it sometimes or never, check that box. **Thank you!**

TYPE OF FOOD OR DRINK	HOW MANY TIMES EACH DAY	If not every day, HOW MANY TIMES EACH WEEK	SOMETIMES OR NEVER
MILK			
100% JUICE			
SODA			
OTHER DRINKS (for example: fruit drinks, iced tea)			
WATER			
CHEESE			
YOGURT			
VEGETABLES (NOT lettuce, tomatoes or potatoes)			
LETTUCE SALAD			
TOMATOES (fresh or sauce)			
POTATOES			
FRUIT (fresh, canned or frozen)			
CEREAL			
RICE			
BEANS			
BREAD			
TORTILLAS			
NOODLES (for example: pasta, spaghetti, macaroni)			
EGGS			
MEAT (for example: beef or pork)			
CHICKEN			
FISH			
SALTY SNACKS (for example: chips, popcorn)			
SWEETS (for example: candy, cookies, ice cream)			

CHART LABEL HERE

More Questions!

How many times each week do you eat outside food (from restaurants or fast food places)?

_____ times per week

In the last 6 months, was the following often, sometimes, or never true?

The food that I (my family) bought just didn't last, and we didn't have money to get more.

(Check one) Often ___ Sometimes ___ Never ___

I (my family) ate different kinds of foods from week to week depending on how much money we had.

(Check one) Often ___ Sometimes ___ Never ___

Were you born in the United States?

Yes

No

If not born in the US, what country were you born in? _____

If you were born outside of the United States, how many YEARS have you lived in the United States?

_____ YEARS

Which language do you prefer to

Speak English Spanish Other

Read English Spanish Other

Do you consider yourself to be Hispanic?

Yes Prefer not to answer

No

I consider myself to be (Check all that apply)

African American Asian

Black White

Native American More than one race

Other Prefer not to answer

Thank you!

APPENDIX B:
'OTHER CRAVINGS' RECODING

<i>Foods</i>	Food Item	MWS 1	MWS 2	<i>Remaining in Other Category</i>
		N	N	
	Chips	1	0	
	Mayonnaise	1	0	
	Milk	1	1	
	Cheese	1	0	
	Pizza	2	0	
	Spicy Food	2	2	
	Subway	1	0	
	Tamales	1	0	
	Tea	1	0	
	Coffee	0	3	
	Soup	0	1	
	Tofu	0	1	
	Total	11	8	

Foods Recoded from Other Category into Standard Categories

<i>Craving Category</i>	MWS 1		MWS 2	
	Food item	N	Food item	N
Sweet	Chocolate	1	Slushes	1
	Ice cream	1	Ice cream	4
	Sweet drinks	1	Pancakes	1
			Soda	1
			Smoothie	1
Salty	Pickles	1	Baking soda	1
Starchy	Spaghetti	1	Pasta	1
Fruit/vegetable	Apple juice	1		0
Protein	Seafood	1	Seafood/fish	6

REFERENCES

- Adam, Tanja C., & Epel, Elissa S. (2007). Stress, eating, and the reward system. *Physiology & Behavior*, *91*, 449-458.
- Adegboye, Amanda R. A., Rossner, Stephan, Neovius, Martin, Lourenço, Paulo Mauricio C., & Linné, Yvonne. (2010). Relationships between prenatal smoking cessation, gestational weight gain and maternal lifestyle characteristics. *Women and Birth*, *23*(1), 29-35. doi: 10.1016/j.wombi.2009.05.002
- Albers, Leah L., Greulich, Betsy, & Peralta, Patricia. (2006). Body mass index, midwifery intrapartum care, and childbirth lacerations. *Journal of Midwifery & Women's Health*, *51*(4), 249-253.
- Alberts, Hugo J. E. M., Mulkens, Sandra, Smeets, Maud, & Thewissen, Roy. (2010). Coping with food cravings. Investigating the potential of a mindfulness-based intervention. *Appetite*, *55*(1), 160-163. doi: 10.1016/j.appet.2010.05.044
- Allison, Kelly C, Wrotniak, Brian H, Par´e, Emmanuelle , & Sarwer, David. (2012). Psychosocial characteristics and gestational weight change among overweight African American pregnant women. *Obstetrics and Gynecology International*. doi: 10.1155/2012/878607
- Althuizen, Ellen, van Poppel, Mireille , Seidell, Jacob , & van Mechelen, Willem. (2009). Correlates of absolute and excessive weight gain during pregnancy. *Journal of Women's Health*, *18*(10), 1559-1566. doi: doi:10.1089/jwh.2008.1275.
- American College of Nurse-Midwives. (2012). Midwifery evidence-based practice: A summary of research on midwifery practice in the United States. Retrieved December 19, 2012, from <http://www.midwife.org/ACNM/files/ccLibraryFiles/Filename/000000002128/Midwifery%20Evidence-based%20Practice%20Issue%20Brief%20FINALMAY%202012.pdf>
- Amorim, Amanda R., Rossner, Stephan, Neovius, Martin, Lourenco, Paulo M., & Linne, Yvonne. (2007). Does excess pregnancy weight gain constitute a major risk for increasing long-term BMI? *Obesity*, *15*(5), 1278-1286.
- Anschutz, Doeschka J., Van Strien, Tatjana, Van De Ven, Monique O. M., & Engels, Rutger C. M. E. (2009). Eating styles and energy intake in young women. *Appetite*, *53*(1), 119-122 doi:110.1016/j.appet.2009.1003.1016.
- Arroll, B, Khin, N, & Kerse, N (2003). Screening for depression in primary care with two verbally asked questions: Cross sectional study. *British Medical Journal*, *327*(15), 1144-1146.

- Augustine, Rachael A., Ladyman, Sharon R., & Grattan, David R. (2008). From feeding one to feeding many: Hormone-induced changes in body weight homeostasis during pregnancy. *Journal of Physiology*, 387–397.
- Bellamy, Leanne, Casas, Juan-Pablo, Hingorani, Aroon, & Williams, David J (2007). Pre-eclampsia and risk of cardiovascular disease and cancer in later life: Systematic review and meta-analysis. *British Medical Journal*, 335(7627), 974. doi: 10.1136/bmj.39335.385301.BE
- Belzer, L, Smulian, John C. , Lu, Shou-E, & Tepper, Beverly J. . (2010). Food cravings and intake of sweet foods in healthy pregnancy and mild gestational diabetes mellitus. A prospective study. *Appetite*, 55, 609-615. doi: 10.1016/j.appet.2010.09.014
- Belzer, L, Smulian, John C., Lu, Shou-En, & Tepper, Beverly J. (2009). Changes in sweet taste across pregnancy in mild gestational diabetes mellitus: Relationship to endocrine factors. *Chemical Senses*, 34(7), 595-605. doi: 10.1093/chemse/bjp041
- Bennett, Ian, Coco, Andrew, Coyne, James, Mitchell, Alex, Nicholson, James, Johnson, Ellen, . . . Ratcliffe, Stephen. (2008). Efficiency of a two-item pre-screen to reduce the burden of depression screening in pregnancy and postpartum: An IMPLICIT Network Study. *Journal of the American Board of Family Medicine* 21(4), 317-325. doi: 10.3122/jabfm.2008.04.080048
- Blaine, Bruce. (2008). Does depression cause obesity? A meta-analysis of longitudinal studies of depression and weight control. *Journal of Health Psychology*, 13, 1190-1197.
- Brawarsky, P., Stotland, N. E., Jackson, R. A., Fuentes-Afflick, E., Escobar, G. J., Rubashkin, N., & Haas, J. S. (2005). Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. *International Journal of Gynecology & Obstetrics*, 91(2), 125-131. doi: 10.1016/j.ijgo.2005.08.008
- Burton, Pat, J. Smit, Hendrik, & J. Lightowler, Helen. (2007). The influence of restrained and external eating patterns on overeating. *Appetite*, 49(1), 191-197 doi: 10.1016/j.appet.2007.01.007
- Campbell, F, Johnson, M, Messina, J, Guillaume, L, & Goyder, E. (2011). Behavioural interventions for weight management in pregnancy: A systematic review of quantitative and qualitative data. *BMC Public Health*, 11(1).
- Carey, Mariko, Small, Hannah, Yoong, Sze Lin, Boyes, Allison, Bisquera, Alessandra, & Sanson-Fisher, Rob. (2014). *Prevalence of comorbid depression and obesity in general practice: a cross-sectional survey* (Vol. 64).
- Catalano, Patrick M. (2010). Obesity, insulin resistance, and pregnancy outcome. *Reproduction*, 140(3), 365-371. doi: 10.1530/rep-10-0088

- Catalano, Patrick M., Presley, Lorraine, Minium, Judi, & Hauguel-de Mouzon, Sylvie. (2009). Fetuses of obese mothers develop insulin resistance in utero. *Diabetes Care*, *32*(6), 1076-1080.
- Cepeda-Benito, Antonio, Fernandez, Mari Carmen, & Moreno, Silvia. (2003). Relationship of gender and eating disorder symptoms to reported cravings for food: Construct validation of state and trait craving questionnaires in Spanish. *Appetite*, *40*(1), 47-54. doi: 10.1016/S0195-6663(02)00145-9
- Cepeda-Benito, Antonio, Gleaves, David H, Williams, Tara L, & Erath, Stephen A. (2000). The development and validation of the State and Trait Food-Cravings Questionnaires. *Behavior Therapy*, *31*, 151-173.
- Chao, A., Grilo, C. M., White, M. A., & Sinha, R. (2014). Food cravings, food intake, and weight status in a community-based sample. *Eating Behaviors*, *15*(3), 478-482.
- Chasan-Taber, Lisa, Schmidt, Michael D., Pekow, Penelope, Sternfeld, Barbara, Solomon, Caren G., & Markenson, Glenn. (2008). Predictors of excessive and inadequate gestational weight gain in Hispanic women. *Obesity*, *16*(7), 1657-1666.
- Cheng, Yvonne W., Chung, Judith H., Kurbisch-Block, Ingrid, Inturrisi, Maribeth, Shafer, Sherri, & Caughey, Aaron B. (2008). Gestational weight gain and gestational diabetes mellitus: Perinatal outcomes. *Obstetrics & Gynecology*, *112*(5), 1015-1022.
- Christensen, L. (2007). Craving for sweet carbohydrate and fat-rich foods – possible triggers and impact on nutritional intake. *Nutrition Bulletin*, *32*, 43-51. doi: 10.1111/j.1467-3010.2007.00615.x
- Chu, Susan Y., Callaghan, William M., Bish, Connie L., & D'Angelo, Denise. (2009). Gestational weight gain by body mass index among US women delivering live births, 2004-2005: Fueling future obesity. *American Journal of Obstetrics and Gynecology*, *200*(3), 271.e271-277.
- Clark, M, & Ogden, J. (1999). The impact of pregnancy on eating behavior and aspects of weight concern. *International Journal of Obesity*, *23*(1), 18-24.
- Crane, J. M., White, J., Murphy, P., Burrage, L., & Hutchens, D. (2009). The effect of gestational weight gain by body mass index on maternal and neonatal outcomes. *Journal of Obstetrics & Gynaecology Canada: JOGC*, *31*(1), 28-35.
- Crystal, Susan R., Bowen, Deborah J., & Bernstein, Ilene L. (1999). Morning sickness and salt intake, food cravings, and food aversions. *Physiology & Behavior*, *67*(2), 181-187. doi: 10.1016/s0031-9384(99)00055-4

- Dalenius, K, Brindley, P, Smith, B, Reinold, C, & Grummer-Strawn, L. (2012). Pregnancy Nutrition Surveillance 2010 Report. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, from http://www.cdc.gov/pednss/pdfs/2010-PNSS-Summary_Report.pdf
- Davis, Caroline, Patte, Karen, Levitan, Robert, Reid, Caroline, Tweed, Stacey, & Curtis, Claire. (2007). From motivation to behaviour: A model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. *Appetite*, *48*(1), 12-19
doi:10.1016/j.appet.2006.1005.1016.
- De Vriendt, Tineke, Clays, Els, Maes, Lea, De Bourdeaudhuij, Ilse, Vicente-Rodriguez, Germàn, Moreno, Luis A., . . . De Henauw, Stefaan. (2012). European adolescents' level of perceived stress and its relationship with body adiposity—The HELENA Study. *The European Journal of Public Health*, *22*(4), 519-524. doi: 10.1093/eurpub/ckr134
- Derbyshire, E., Davies, J., Costarelli, V., & Dettmar, P. (2006). Prepregnancy body mass index and dietary intake in the first trimester of pregnancy. *Journal of Human Nutrition & Dietetics*, *19*(4), 267-273.
- Dickens, G., & Trethowan, W. H. (1971). Cravings and aversions during pregnancy. *Journal of Psychosomatic Research*, *15*(3), 259-268. doi: 10.1016/0022-3999(71)90037-7
- Ding, Xiu-Xiu, Wu, Yi-Le, Xu, Shao-Jun, Zhu, Ruo-Ping, Jia, Xiao-Min, Zhang, Shi-Fen, . . . Tao, Fang-Biao. (2014). Maternal anxiety during pregnancy and adverse birth outcomes: A systematic review and meta-analysis of prospective cohort studies. *Journal of Affective Disorders*, *159*, 103-110. doi: 10.1016/j.jad.2014.02.027
- Douglas, Alison J., Johnstone, Louise E., & Leng, Gareth. (2007). Neuroendocrine mechanisms of change in food intake during pregnancy: A potential role for brain oxytocin. *Physiology & Behavior*, *91*(4), 352-365. doi: 10.1016/j.physbeh.2007.04.012
- Duarte-Salles, Talita, Mendez, Michelle A, Pessoa, Verónica, Guxens, Mònica, Aguilera, Inmaculada, Kogevinas, Manolis, & Sunyer, Jordi. (2010). Smoking during pregnancy is associated with higher dietary intake of polycyclic aromatic hydrocarbons and poor diet quality. *Public Health Nutrition*, *13*(12), 2034-2043. doi: doi:10.1017/S1368980010001278
- Dunkel Schetter, Christine , & Tanner, Lynlee (2012). Anxiety, depression and stress in pregnancy: Implications for mothers, children, research, and practice. *Current Opinion in Psychiatry*, *25*, 141–148. doi: 10.1097/YCO.0b013e3283503680
- Ehrlich, S. F. (2011). Change in Body Mass Index between pregnancies and the risk of gestational diabetes in a second pregnancy. *Obstetrics & Gynecology*, *117*(6), 1323.

- Fairburn, CG, Stein, A, & Jones, R. (1992). Eating habits and eating disorders during pregnancy. *Psychosomatic Medicine*, 54(6), 665-672.
- Favaretto, Ana L., Duncan, Bruce B., Mengue, Sotero S., Nucci, Luciana B., Barros, Enrique F., Kroeff, Locimara R., . . . Schmidt, Maria I. (2007). Prenatal weight gain following smoking cessation. *European Journal of Obstetrics, Gynecology, & Reproductive Biology*, 135(2), 149-153.
- Feig, Denise S., Zinman, Bernard, Wang, Xuesong, & Hux, Janet E. (2008). Risk of development of diabetes mellitus after diagnosis of gestational diabetes. *Canadian Medical Association Journal*, 179(3), 229-234. doi: 10.1503/cmaj.080012
- Field, Alison E., Coakley, Eugenie H., Must, Aviva, Spadano, Jennifer L., Laird, Nan, Dietz, William H., . . . Colditz, Graham A. (2001). Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine*, 161(13), 1581-1586. doi: 10.1001/archinte.161.13.1581
- Field, Andy. (2009). *Discovering Statistics Using SPSS* (3 ed.). London: Sage Publications LTD.
- Figlewicz, Dianne P., & Benoit, Stephen C. (2009). Insulin, leptin, and food reward: Update 2008. *American Journal of Physiology - Regulatory, Integrative and Comparative Physiology*, 296(1), R9-R19. doi: 10.1152/ajpregu.90725.2008
- Finely, D.A, Dewey, K. G, Lonnerdal, B.O, & Grivetti, Louis E. (1985). Food choices of vegetarians and nonvegetarians during pregnancy and lactation. *Journal of The American Dietetic Association*, 85(6), 678-685.
- Flegal, Katherine M., Carroll, Margaret D., Ogden, Cynthia L., & Curtin, Lester R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *JAMA-Journal of the American Medication Association*, 303(3), 235-241. doi: 10.1001/jama.2009.2014
- Fortner, Renee Turzanski, Pekow, Penelope, Solomon, Caren G., Markenson, Glenn, & Chasan-Taber, Lisa. (2009). Prepregnancy body mass index, gestational weight gain, and risk of hypertensive pregnancy among Latina women. *American Journal of Obstetrics and Gynecology*, 200(2), 167.e161-167.
- Fowles, Eileen R., Bryant, Miranda, Kim, SungHun, Walker, Lorraine O., Ruiz, Roberta Jeanne, Timmerman, Gayle M., & Brown, Adama. (2011). Predictors of dietary quality in low-income pregnant women: A path analysis. *Nursing Research*, 60(5), 286-294
210.1097/NNR.1090b1013e3182266461.
- Fowles, Eileen R., Murphey, Christina, & Ruiz, Roberta Jeanne. (2011). Exploring relationships among psychosocial status, dietary quality, and measures of placental development during the first trimester in low-income women. *Biological Research for Nursing*, 13(1), 70-79. doi: 10.1177/1099800410378733

- Franken, Ingmar H. A., & Muris, Peter. (2005). Individual differences in reward sensitivity are related to food craving and relative body weight in healthy women. *Appetite*, *45*(2), 198-201. doi: 10.1016/j.appet.2005.04.004
- Fraser, Abigail, Tilling, Kate, Macdonald-Wallis, Corrie, Hughes, Rachael, Sattar, Naveed, Nelson, Scott M, & Lawlor, Debbie A. (2011). Associations of gestational weight gain with maternal body mass index, waist circumference, and blood pressure measured 16 y after pregnancy: the Avon Longitudinal Study of Parents and Children (ALSPAC). *American Journal of Clinical Nutrition*, *93*(6), 1285-1292. doi: 10.3945/ajcn.110.008326
- Frederick, Ihunnaya O., Rudra, Carole B., Miller, Raymond S., Foster, Julie C., & Williams, Michelle A. (2006). Adult weight change, weight cycling, and prepregnancy obesity in relation to risk of preeclampsia. *Epidemiology*, *17*(4), 428-434.
- Frederick, Ihunnaya O., Williams, Michelle A., Sales, Anne E., Martin, Diane P., & Killien, Marcia. (2008). Pre-pregnancy body mass index, gestational weight gain, and other maternal characteristics in relation to infant birth weight. *Maternal and Child Health Journal*, *12*(5), 557-567.
- Fulton, Stephanie. (2010). Appetite and reward. *Frontiers in Neuroendocrinology*, *31*(1), 85-103. doi: 10.1016/j.yfrne.2009.10.003
- Gardner, B., Wardle, J., Poston, L., & Croker, H. (2011). Changing diet and physical activity to reduce gestational weight gain: A meta-analysis. *Obesity Reviews*, *12*(7), e602-e620. doi: 10.1111/j.1467-789X.2011.00884.x
- Geliebter, Allan, & Aversa, Angela. (2003). Emotional eating in overweight, normal weight, and underweight individuals. *Eating Behaviors*, *3*(4), 341-347. doi: 10.1016/S1471-0153(02)00100-9
- Gendall, Kelly A., Joyce, Peter R., & Sullivan, Patrick F. (1997). Impact of definition on prevalence of food cravings in random sample of young women. *Appetite*, *28*(1), 63-72. doi: 10.1006/appe.1996.0060
- George, Goldy C., Hanss-Nuss, Henry, Milani, Tracey J., & Freeland-Graves, Jeanne H. (2005). Food choices of low-income women during pregnancy and postpartum. *Journal of the American Dietetic Association*, *105*(6), 899-907. doi: 10.1016/j.jada.2005.03.028
- Getahun, D., Ananth, C. V., Oyelese, Y., Chavez, M. R., Kirby, R. S., & Smulian, J. C. (2007). Primary preeclampsia in the second pregnancy: effects of changes in prepregnancy body mass index between pregnancies. *Obstetrics & Gynecology*, *110*(6), 1319-1325. doi: 10.1097/01.AOG.0000292090.40351.30

- Glanz, Karen, & Schwartz, Marc D. (2008). Stress, coping, and health behavior. In K. Glanz, B. K. Rimer & K. Viswanath (Eds.), *Health Behavior and Health Education: Theory, Research, and Practice* (4 ed., pp. 211-236). San Francisco: B Jossey-Bass.
- Gore, Stacy, Brown, Della, & West, Delia. (2003). The role of postpartum weight retention in obesity among women: A review of the evidence. *Annals of Behavioral Medicine*, 26(2), 149-159. doi: 10.1207/s15324796abm2602_07
- Gould Rothberg, Bonnie E., Magriples, Urania, Kershaw, Trace S., Rising, Sharon Schindler, & Ickovics, Jeannette R. (2011). Gestational weight gain and subsequent postpartum weight loss among young, low-income, ethnic minority women. *American Journal of Obstetrics and Gynecology*, 204(1), 52.e51-52.e11.
- Grattan, David R., Ladyman, Sharon R., & Augustine, Rachael A. (2007). Hormonal induction of leptin resistance during pregnancy. *Physiology & Behavior*, 91(4), 366-374.
- Green, Samuel B. (1991). How Many Subjects Does It Take To Do A Regression Analysis. *Multivariate Behavioral Research*, 26(3), 499-510. doi: 10.1207/s15327906mbr2603_7
- Gunderson, Erica P. (2009). Childbearing and obesity in women: Weight before, during, and after pregnancy. *Obstetrics and Gynecology Clinics of North America*, 36(2), 317-332. doi: 10.1016/j.ogc.2009.04.001
- Hamed, E. A., Zakary, M. M., Ahmed, N. S., & Gamal, R. M. (2011). Circulating leptin and insulin in obese patients with and without type 2 diabetes mellitus: Relation to ghrelin and oxidative stress. *Diabetes Research and Clinical Practice*, 94(3), 434-441. doi: 10.1016/j.diabres.2011.08.023
- HAPO Study Cooperative Research Group. (2002). The Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Study. *International Journal of Gynecology & Obstetrics*, 78(1), 69-77. doi: [http://dx.doi.org/10.1016/S0020-7292\(02\)00092-9](http://dx.doi.org/10.1016/S0020-7292(02)00092-9)
- Harper, P A, & Wiener, G. (1965). Sequelae of Low Birth Weight. *Annual Review of Medicine*, 16(1), 405-418. doi: 10.1146/annurev.me.16.020165.002201
- Hedderson, Monique M., Gunderson, Erica P., & Ferrara, Assiamira. (2010). Gestational weight gain and risk of gestational diabetes mellitus. *Obstetrics & Gynecology* 115(3), 597-604.
- Herring, Sharon J., Nelson, Deborah B., Davey, Adam, Klotz, Alicia A., Dibble, La Vette, Oken, Emily, & Foster, Gary D. (2012). Determinants of excessive gestational weight gain in urban, low-income women. *Women's Health Issues*, 22(5), e439-e446. doi: <http://dx.doi.org/10.1016/j.whi.2012.05.004>

- Hill, A. J., & McCance, D. R. (2014). Anthropometric and nutritional associations of food cravings in pregnancy. *Pregnancy Hypertension: An International Journal of Women's Cardiovascular Health*. Retrieved September 10, 2014, from <http://www.sciencedirect.com/science/article/pii/S2210778914000373>
- Hill, Andrew J. (2007). The psychology of food craving. *Proceedings of the Nutrition Society*, 66, 277-285. doi: 10.1017/S0029665107005502
- Hill, B., Skouteris, H., & Fuller-Tyszkiewicz, M. (2013). Interventions designed to limit gestational weight gain: A systematic review of theory and meta-analysis of intervention components. *Obesity Reviews*, 14(6), 435-450. doi: 10.1111/obr.12022
- Hook, E.B. (1978). Dietary cravings and aversions during pregnancy. *American Journal of Clinical Nutrition*, 31(8), 1355-1362.
- Hurley, Kristen M., Caulfield, Laura E., Sacco, Lisa M., Costigan, Kathleen A., & Dipietro, Janet A. (2005). Psychosocial influences in dietary patterns during pregnancy. *Journal of the American Dietetic Association*, 105(6), 963-966. doi: 10.1016/j.jada.2005.03.007
- Institute of Medicine, & National Research Council. (2009). *Weight gain during pregnancy: Reexamining the guidelines*. Washington, DC: National Academy Press. Retrieved from http://books.nap.edu/openbook.php?record_id=12584.
- Jaaskelainen, Anne, Nevanpera, Nina, Remes, Jouko, Rahkonen, Fanni, Jarvelin, Marjo-Riitta, & Laitinen, Jaana. (2014). Stress-related eating, obesity and associated behavioural traits in adolescents: A prospective population-based cohort study. *BMC Public Health*, 14(1), 321.
- Jastreboff, Ania M., Sinha, Rajita, Lacadie, Cheryl, Small, Dana M., Sherwin, Robert S., & Potenza, Marc N. (2013). Neural correlates of stress- and food cue-induced food craving in obesity: Association with insulin levels. *Diabetes Care*, 36(2), 394-402. doi: 10.2337/dc12-1112
- Jeffries, Kirby, Shub, Alexis, Walker, Susan P, Hiscock, Richard, & Permezel, Michael (2009). Reducing excessive weight gain in pregnancy: A randomised controlled trial. *The Medical Journal of Australia*, 191(8), 429-433.
- Jenks, Rebecca A, & Higgs, Suzanne. (2011). Reactivity to smoking- and food-related cues in currently dieting and non-dieting young women smokers. *Journal of Psychopharmacology*, 25(4), 520-529. doi: 10.1177/0269881109359093

- Johnson, Julie, Clifton, Rebecca G., Roberts, James M., Myatt, Leslie, Hauth, John C., Spong, Catherine Y., . . . Health, for the Eunice Kennedy Shriver National Institute of Child. (2013). Pregnancy outcomes with weight gain above or below the 2009 Institute of Medicine guidelines. *Obstetrics & Gynecology*, *121*(5), 969-975
910.1097/AOG.1090b1013e31828aea31803.
- Joost, Hans-Georg. (2012). Appetite Control. In F. B. Hofmann München (Ed.), *Handbook of Experimental Pharmacology* (Vol. 209): Springer Link. Retrieved from <http://www.springerlink.com/content/978-3-642-24715-6/#section=1019758&page=1&locus=0>. doi: 10.1007/978-3-642-24716-3
- Kelly, Shona J , Daniell, Mark, Dal Grande, Eleonora, & Taylor, Anne (2011). Mental ill-health across the continuum of body mass index. *BMC Public Health*, *11*(765). doi: 10.1186/1471-2458-11-765
- Keski-Rahkonen, A., Bulik, C. M., Pietilainen, K. H., Rose, R. J., Kaprio, J., & Rissanen, A. (2007). Eating styles, overweight and obesity in young adult twins. *European Journal of Clinical Nutrition*, *61*(7), 822-829.
- Kieffer, Edith C., Tabaei, Bahman P., Carman, Wendy J., Nolan, George H., Guzman, J. Ricardo, & Herman, William H. (2006). The influence of maternal weight and glucose tolerance on infant birthweight in Latino mother-infant pairs. *American Journal of Public Health*, *96*(12), 2201-2208.
- Kim, Catherine, Newton, Katherine M., & Knopp, Robert H. (2002). Gestational diabetes and the incidence of Type 2 diabetes. *Diabetes Care*, *25*(10), 1862-1868. doi: 10.2337/diacare.25.10.1862
- Kim, Shin Y, Sharma, Andrea J, Sappenfield, William, Wilson, Hoyt G, & Salihu, Hamisu M. (2014). Association of maternal body mass index, excessive weight gain, and gestational diabetes mellitus with large-for-gestational-age births. *Obstetrics & Gynecology*, *123*(4), 737-744 710.1097/AOG.0000000000000177.
- Kjos, S L, Peters, R K, Xiang, A, Henry, O A, Montoro, M, & Buchanan, T A. (1995). Predicting future diabetes in Latino women with gestational diabetes. Utility of early postpartum glucose tolerance testing. *Diabetes*, *44*(5), 586-591. doi: 10.2337/diabetes.44.5.586
- Klok, M.D., Jakobsdottir, S., & Drent, M.L. (2007). The role of leptin and ghrelin in the regulation of food intake and body weight in humans: a review. *Obesity Reviews*, *8*, 21-34. doi: 10.1111/j.1467-789X.2006.00270.x
- Kralik, Debbie , Visentin, Kate , & van Loon, Antonia. (2006). Transition: A literature review. *Journal of Advanced Nursing*, *55*(3), 320-329.

- Kroenke, Kurt, Spitzer, Robert L., Williams, Janet B. W., & Löwe, Bernd. (2010). The Patient Health Questionnaire somatic, anxiety, and depressive symptom scales: a systematic review. *General Hospital Psychiatry, 32*(4), 345-359.
- Kroenke, Kurt, Spitzer, Robert, & Williams, Janet. (2003). The Patient Health Questionnaire-2: Validity of a two-item depression screener. *Medical Care, 41*(11), 1284-1292.
- Krukowski, Rebecca , Bursac, Zoran, McGehee, Mary , & Delia, West. (2013). Exploring potential health disparities in excessive gestational weight gain. *Journal of Women's Health, 22*(6), 494-500. doi: 10.1089/jwh.2012.3998.
- Lagiou, P., Tamimi, R. M., Mucci, L. A., Adami, H. O., Hsieh, C. C., & Trichopoulos, D. (2004). Diet during pregnancy in relation to maternal weight gain and birth size. *European Journal of Clinical Nutrition, 58*(2), 231-237. doi: 10.1038/sj.ejcn.1601771
- Lan-Pidhainy, Xiaomiao, Nohr, Ellen A, & Rasmussen, Kathleen M. (2013). Comparison of gestational weight gain-related pregnancy outcomes in American primiparous and multiparous women. *American Journal of Clinical Nutrition, 97*(5), 1100-1106. doi: 10.3945/ajcn.112.052258
- Laraia, Barbara A, Bodnar, Lisa M, & Siega-Riz, Anna Maria. (2007). Pregravid body mass index is negatively associated with diet quality during pregnancy. *Public Health Nutrition, 10*(09), 920-926. doi: doi:10.1017/S1368980007657991
- Leibowitz, Sarah, & Wortley, Katherine. (2004). Hypothalamic control of energy balance: Different peptides, different functions. *Peptides, 25*, 473-504.
- Levine, Michele D., Cheng, Yu, Cluss, Patricia A., Marcus, Marsha D., & Kalarchian, Melissa A. (2013). Prenatal smoking cessation intervention and gestational weight gain. *Women's Health Issues, 23*(6), e389-e393. doi: <http://dx.doi.org/10.1016/j.whi.2013.07.005>
- Linne, Y., & Neovius, M. (2006). Identification of women at risk of adverse weight development following pregnancy. *International Journal of Obesity, 30*(8), 1234-1239.
- Littman, Alyson J., White, Emily, Satia, Jessie A., Bowen, Deborah J., & Kristal, Alan R. (2006). Reliability and validity of 2 Single-Item Measures of Psychosocial Stress. *Epidemiology, 17*, 398-403.
- Lobel, Marci, Cannella, Dolores Lacey, Graham, Jennifer E., DeVincent, Carla, Schneider, Jayne, & Meyer, Bruce A. (2008). Pregnancy-specific stress, prenatal health behaviors, and birth outcomes. *Health Psychology, 27*(5), 604.
- Luke, B., Keith, L., & Keith, D. (1997). Maternal nutrition in twin gestations: Weight gain, cravings and aversions, and sources of nutrition advice. *Acta Geneticae Medicae et Gemellologiae: Twin Research, 46*(3), 157-166.

- Lundren, Ingela, & Wahlberg, Vivian. (1999). The experience of pregnancy: A hermeneutical/phenomenological study. *Journal of Perinatal Education*, 8(3), 12-20.
- Macht, Michael. (2008). How emotions affect eating: A five-way model. *Appetite*, 50(1), 1-11. doi: 10.1016/j.appet.2007.07.002
- MacKay, Andrea P., Berg, Cynthia J., & Atrash, Hani K. (2001). Pregnancy-related mortality from preeclampsia and eclampsia. *Obstetrics & Gynecology*, 97(4), 533-538. doi: 10.1016/S0029-7844(00)01223-0
- Mahler, S. V., & de Wit, H. . (2010). Cue-reactors: Individual differences in cue-induced craving after food or smoking abstinence. *PLOS ONE* 5(11). doi: 10.1371/journal.pone.0015475
- Mamun, Abdullah A, Kinarivala, Mansey, O'Callaghan, Michael J, Williams, Gail M, Najman, Jake M, & Callaway, Leonie K. (2010). Associations of excess weight gain during pregnancy with long-term maternal overweight and obesity: Evidence from 21 y postpartum follow-up. *American Journal of Clinical Nutrition*, 91(5), 1336-1341. doi: 10.3945/ajcn.2009.28950
- Mamun, Abdullah A, O'Callaghan, Michael, Callaway, Leonie, Williams, Gail, Najman, Jake, & Lawlor, Debbie A. (2009). Associations of gestational weight gain with offspring body mass index and blood pressure at 21 years of age: Evidence from a birth cohort study. *Circulation*, 119(13), 1720-1727.
- Mannan, Munim, Doi, Suhail A. R., & Mamun, Abdullah A. (2013). Association between weight gain during pregnancy and postpartum weight retention and obesity: A bias-adjusted meta-analysis. *Nutrition Reviews*, 71(6), 343-352. doi: 10.1111/nure.12034
- Margerison Zilko, Claire E., Rehkopf, David, & Abrams, Barbara. (2010). Association of maternal gestational weight gain with short- and long-term maternal and child health outcomes. *American Journal of Obstetrics and Gynecology*, 202(6), 574.e571-574.e578. doi: 10.1016/j.ajog.2009.12.007
- Mathews, Fiona, Yudkin, Patricia, Smith, Robert F, & Neil, Andrew. (2000). Nutrient intakes during pregnancy: the influence of smoking status and age. *Journal of Epidemiology and Community Health*, 54(1), 17-23. doi: 10.1136/jech.54.1.17
- Matte, T, Ellis, JA, Bedell, J, Selenic, D, Young, C, & Deitcher, D (2007). Obesity in the South Bronx: A look across generations. Retrieved November 20, 2012, from <http://www.nyc.gov/html/doh/downloads/pdf/dpho/dpho-bronx-obesity.pdf>
- Matthey, Stephen, & Ross-Hamid, Clodagh. (2011). The validity of DSM symptoms for depression and anxiety disorders during pregnancy. *Journal of Affective Disorders*, 133(3), 546-552. doi: 10.1016/j.jad.2011.05.004

- McCormick, M.C. (1985). The contribution of low birth weight to infant mortality and childhood morbidity. *New England Journal of Medicine*, 82-90.
- Mercer, Michele E., & Holder, Mark D. (1997). Food cravings, endogenous opioid peptides, and food intake: A review. *Appetite*, 29(3), 325-352. doi: DOI: 10.1006/appe.1997.0100
- Meule, A, Hermann, T, & Kübler, A. (2014). A short version of the Food Cravings Questionnaire-Trait: the FCQ-T-reduced. *Frontiers in Psychology*, 5(190). doi: 10.3389/fpsyg.2014.00190.
- Neary, Nicola Marguerite , Goldstone, Anthony Peter , & Bloom, Stephen Robert (2004). Appetite regulation: From gut to the hypothalamus. *Clinical Endocrinology*, 60(2), 153-160. doi: 10.1046/j.1365-2265.2003.01839.x
- Nehring, I., Lehmann, S., & von Kries, R. (2013). Gestational weight gain in accordance to the IOM/NRC criteria and the risk for childhood overweight: A meta-analysis. *Pediatric Obesity*, 8(3), 218-224. doi: 10.1111/j.2047-6310.2012.00110.x
- Newbern, D., & Freemark, M. (2011). Placental hormones and the control of maternal metabolism and fetal growth. *Current Opinion in Endocrinology Diabetes, and Obesity*, 18(6), 409-416. doi: 10.1097/MED.0b013e32834c800d
- Ng, Longena, & Davis, Caroline. (2013). Cravings and food consumption in binge eating disorder. *Eating Behaviors*, 14(4), 472-475. doi: <http://dx.doi.org/10.1016/j.eatbeh.2013.08.011>
- Nielsen, Naja Rod, Kristensen, Tage S., Schnohr, Peter, & Grønbæk, Morten. (2008). Perceived stress and cause-specific mortality among men and women: Results from a prospective cohort study. *American Journal of Epidemiology*, 168(5), 481-491. doi: 10.1093/aje/kwn157
- Nohr, Ellen A., Vaeth, Michael, Baker, Jennifer L., Sorensen, Thorkild Ia, Olsen, Jorn, & Rasmussen, Kathleen M. (2008). Combined associations of prepregnancy body mass index and gestational weight gain with the outcome of pregnancy. *American Journal of Clinical Nutrition*, 87(6), 1750-1759.
- NYC. (2013). NYC Census Fact Finder. Retrieved April 30, 2013, from <http://maps.nyc.gov/census/?searchType=AddressSearch&addressNumber=1029&street=EAST++163+STREET&borough=bronx>
- NYC department of City Planning.). Bronx Community District 2 Neighborhoods: Hunts Point, Longwood. Retrieved April 30, 2013, from http://www.nyc.gov/html/dcp/html/neighborhood_info/bx02_info.shtml

- Oken, Emily, Kleinman, Ken P., Belfort, Mandy B., Hammitt, James K., & Gillman, Matthew W. (2009). Associations of gestational weight gain with short- and longer-term maternal and child health outcomes. *American Journal of Epidemiology*, *170*(2), 173-180.
- Oken, Emily, Rifas-Shiman, Sheryl L., Field, Alison E., Frazier, A. Lindsay, & Gillman, Matthew W. (2008). Maternal gestational weight gain and offspring weight in adolescence. *Obstetrics & Gynecology*, *112*(5), 999-1006.
- Olafsdottir, A., Skuladottir, G., Thorsdottir, I., Hauksson, A., & Steingrimsdottir, L. (2006). Maternal diet in early and late pregnancy in relation to weight gain. *International Journal of Obesity*, *30*(3), 492-499. doi: <http://dx.doi.org/10.1038/sj.ijo.0803184>
- Olson, C, Strawderman, M, & Reed, R. (2004). Efficacy of an intervention to prevent excessive gestational weight gain. *American Journal of Obstetrics and Gynecology*, *191*, 530-536.
- Olson, C. M., Strawderman, M. S., Hinton, P. S., & Pearson, T. A. (2003). Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 y postpartum. *International Journal of Obesity and Related Metabolic Disorders*, *27*(1), 117-127. doi: 10.1038/sj.ijo.0802156
- Olson, C., & Strawderman, M. (2003). Modifiable behavioral factors in a biopsychosocial model predict inadequate and excessive gestational weight gain. *Journal of the American Dietetic Association*, *103*(1), 48-54.
- Olson, Christine, Strawderman, Myla, & Dennison, Barbara. (2009). Maternal weight gain during pregnancy and child weight at age 3 years. *Maternal Child Health Journal*, *13*(6), 839-846. doi: 10.1007/s10995-008-0413-6
- Olson, EC, Van Wyke, G, Kerker, B, Thorpe, L, & Frieden, TR. (2006). Take Care Hunts Point and Mott Haven. *NYC Community Health Profiles 7*(42), 1-6.
- Ouwens, Machteld A., van Strien, Tatjana, & van Leeuwe, Jan F. J. (2009). Possible pathways between depression, emotional and external eating. A structural equation model. *Appetite*, *53*(2), 245-248 doi: 210.1016/j.appet.2009.1006.1001.
- Ozier, Amy D., Kendrick, Olivia W., Leeper, J., Knol, Linda L., Perko, Mike, & Burnham, Joy. (2008). Overweight and obesity are associated with emotion- and stress-related eating as measured by the Eating and Appraisal Due to Emotions and Stress Questionnaire. *Journal of American Dietetic Association*, *108*, 49-56.
- Park, Sohyun, Sappenfield, William, Bish, Connie, Salihu, Hamisu, Goodman, David, & Bensyl, Diana. (2011). Assessment of the Institute of Medicine Recommendations for weight gain during pregnancy: Florida, 2004–2007. *Maternal and Child Health Journal*, *15*(3), 289-301. doi: 10.1007/s10995-010-0596-5

- Pepino, M. Yanina, Finkbeiner, Susana, & Mennella, Julie A. (2009). Similarities in food cravings and mood states between obese women and women who smoke tobacco. *Obesity, 17*(6), 1158-1163.
- Phelan, Suzanne, Phipps, Maureen G, Abrams, Barbara, Darroch, Francine, Schaffner, Andrew, & Wing, Rena R. (2011). Randomized trial of a behavioral intervention to prevent excessive gestational weight gain: the Fit for Delivery Study. *American Journal of Clinical Nutrition, 93*(4), 772-779. doi: 10.3945/ajcn.110.005306
- Pick, Mary E., Edwards, Melissa, Moreau, Danielle, & Ryan, Edmond A. (2005). Assessment of diet quality in pregnant women using the Healthy Eating Index. *Journal of the American Dietetic Association, 105*(2), 240-246. doi: 10.1016/j.jada.2004.11.028
- Polley, BA, Wing, RR, & Sims, CJ. (2002). Randomized controlled trial to prevent excessive weight gain in pregnant women. *International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity, 26*(11), 1494-1502.
- Pope, Janet F., Skinner, Jean D. , & Carruth, Betty Ruth. (1992). Cravings and aversions of pregnant adolescents. *Journal of the American Dietetic Association, 92*(12), 1479.
- Pope, Janet F., Skinner, Jean D., & Carruth, Betty Ruth. (1997). Adolescent's self-reported motivations for dietary changes during pregnancy. *Journal of Nutrition Education, 29*(3), 137-144. doi: 10.1016/s0022-3182(97)70178-x
- Reed, Stephanie Collins, Levin, Frances R., & Evans, Suzette M. (2008). Changes in mood, cognitive performance and appetite in the late luteal and follicular phases of the menstrual cycle in women with and without PMDD (premenstrual dysphoric disorder). *Hormones and Behavior, 54*(1), 185-193. doi: <http://dx.doi.org/10.1016/j.yhbeh.2008.02.018>
- Retnakaran, Ravi, Qi, Ying, Sermer, Mathew, Connelly, Philip W., Hanley, Anthony J. G., & Zinman, Bernard. (2008). Glucose intolerance in pregnancy and future risk of pre-diabetes or diabetes. *Diabetes Care, 31*(10), 2026-2031.
- Reynolds, R. M., Osmond, C., Phillips, D. I., & Godfrey, K. M. (2010). Maternal BMI, parity, and pregnancy weight gain: influences on offspring adiposity in young adulthood. *Journal of Clinical Endocrinology and Metabolism, 95*(12), 5365-5369. doi: 10.1210/jc.2010-0697
- Rifas-Shiman, Sheryl L., Rich-Edwards, Janet W., Kleinman, Ken P., Oken, Emily, & Gillman, Matthew W. (2009). Dietary quality during pregnancy varies by maternal characteristics in Project Viva: A US cohort. *Journal of the American Dietetic Association, 109*(6), 1004-1011. doi: 10.1016/j.jada.2009.03.001

- Rod, N. H., Grønbaek, M., Schnohr, P., Prescott, E., & Kristensen, T. S. (2009). Perceived stress as a risk factor for changes in health behaviour and cardiac risk profile: A longitudinal study. *Journal of Internal Medicine*, 266(5), 467-475. doi: 10.1111/j.1365-2796.2009.02124.x
- Rodrigues, P. L., de Oliveira, L. C., Brito Ados, S., & Kac, G. (2010). Determinant factors of insufficient and excessive gestational weight gain and maternal-child adverse outcomes. *Nutrition*, 26(6), 617-623. doi: 10.1016/j.nut.2009.06.025
- Ronnberg, A. K., & Nilsson, K. (2010). Interventions during pregnancy to reduce excessive gestational weight gain: A systematic review assessing current clinical evidence using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system. *BJOG: An International Journal of Obstetrics & Gynaecology*, 117(11), 1327-1334. doi: 10.1111/j.1471-0528.2010.02619.x
- Rooney, Brenda, & Schauberger, Charles. (2002). Excess pregnancy weight gain and long term obesity: One decade later. *Obstetrics & Gynecology*, 100(2), 245-252.
- Ruiz, Jonatan R., Perales, Maria, Pelaez, Mireia, Lopez, Carmina, Lucia, Alejandro, & Barakat, Ruben. (2013). Supervised exercise-based intervention to prevent excessive gestational weight gain: A randomized controlled trial. *Mayo Clinic Proceedings*, 88(12), 1388-1397. doi: <http://dx.doi.org/10.1016/j.mayocp.2013.07.020>
- Sangi-Hagheykar, Haleh, Lam, Kim, & Raine, SusanP. (2014). Gestational weight gain among Hispanic women. *Maternal and Child Health Journal*, 18(1), 153-160. doi: 10.1007/s10995-013-1248-3
- Shin, Dayeon, Bianchi, Leonard, Chung, Hwan, Weatherspoon, Lorraine, & Song, WonO. (2014). Is gestational weight gain associated with diet quality during pregnancy? *Maternal and Child Health Journal*, 18(6), 1433-1443. doi: 10.1007/s10995-013-1383-x
- Siega-Riz, Anna Maria, Viswanathan, Meera, Moos, Merry- K., Deierlein, Andrea, Mumford, Sunni, Knaack, Julie, . . . Lohr, Kathleen N. (2009). A systematic review of outcomes of maternal weight gain according to the Institute of Medicine recommendations: Birthweight, fetal growth, and postpartum weight retention. *American Journal of Obstetrics and Gynecology*, 201(4), 339.e331-339.e314. doi: 10.1016/j.ajog.2009.07.002
- Siega-Riz, Anna Maria, Von Holle, Ann, Haugen, Margaretha, Meltzer, Helle Margrete, Hamer, Robert, Torgersen, Leila, . . . Bulik, Cynthia M. (2011). Gestational weight gain of women with eating disorders in the Norwegian pregnancy cohort. *International Journal of Eating Disorders*, 44(5), 428-434. doi: 10.1002/eat.20835
- Sivaraman, S. C. (2013). Gestational diabetes and future risk of diabetes. *Journal of Clinical Medicine Research*, 5(2), 92. doi: 10.4021/jocmr1201w

- Smith, Megan V., Gotman, Nathan, Lin, Haiqun, & Yonkers, Kimberly A. (2010). Do the PHQ-8 and the PHQ-2 accurately screen for depressive disorders in a sample of pregnant women? *General Hospital Psychiatry*, 32(5), 544-548. doi: 10.1016/j.genhosppsy.2010.04.011
- SPSS Statistics. (Version 22) [Computer software]. Armonk, NY: IBM Corp.
- Stanley, Sarah, Wynne, Katie, McGowan, Barbara, & Bloom, Stephen. (2005). Hormonal regulation of food intake. *Physiology Review*, 85, 1131-1158.
- Stapleton, P., Sheldon, T., Porter, B., & Whitty, J. . (2011). A randomised clinical trial of a meridian-based intervention for food cravings with six-month follow-up. *Behaviour Change*, 28(1), 1-16. doi: 10.1375/bech.28.1.1
- Streuling, I, Beyerlein, A, Rosenfeld, E, Hofmann, H, Schulz, T, & von Kries, R. (2011). Physical activity and gestational weight gain: A meta-analysis of intervention trials. *BJOG: An International Journal of Obstetrics & Gynaecology*, 118(3), 278-284. doi: 10.1111/j.1471-0528.2010.02801.x
- Streuling, I., Beyerlein, A., Rosenfeld, E., Schukat, B., & von Kries, R. (2011). Weight gain and dietary intake during pregnancy in industrialized countries--a systematic review of observational studies. *Journal of Perinatology Medicine*, 39(2), 123-129. doi: 10.1515/JPM.2010.127
- Streuling, Ina, Beyerlein, Andreas, & von Kries, Rüdiger. (2010). Can gestational weight gain be modified by increasing physical activity and diet counseling? A meta-analysis of interventional trials. *American Journal of Clinical Nutrition*, 92(4), 678-687. doi: 10.3945/ajcn.2010.29363
- Styn, Minda A., Bovbjerg, Dana H., Lipsky, Samara, & Erblich, Joel. (2013). Cue-induced cigarette and food craving: A common effect? *Addictive Behaviors*, 38(3), 1840-1843. doi: <http://dx.doi.org/10.1016/j.addbeh.2012.09.010>
- Tabachnik, Barbara, & Fidell, Linda. (2007). Multiple regression *Using Multivariate Statistics* (5 ed., pp. 117-194). Boston: Pearson Education, Inc.
- Table C.4 Critical values of Chi-Square. (2007). In B. Tabachnick & L. Fidell (Eds.), *Using Multivariate Statistics* (5 ed.). Boston: Pearson Education, Inc.
- Tepper, Beverly J, & Seldner, Annie C. (1999). Sweet taste and intake of sweet foods in normal pregnancy and pregnancy complicated by gestational diabetes mellitus. *American Journal of Clinical Nutrition*, 70(2), 277-284.

- Tessier, D. R., Ferraro, Z. M., & Gruslin, A. (2013). Role of leptin in pregnancy: Consequences of maternal obesity. *Placenta*, *34*(3), 205-211. doi: <http://dx.doi.org/10.1016/j.placenta.2012.11.035>
- Tie, Hong-Tao, Xia, Yi-Yin, Zeng, Yong-Sheng, Zhang, Yong, Dai, Chia-Liang, Guo, JeffJianfei, & Zhao, Yong. (2014). Risk of childhood overweight or obesity associated with excessive weight gain during pregnancy: A meta-analysis. *Archives of Gynecology and Obstetrics*, *289*(2), 247-257. doi: 10.1007/s00404-013-3053-z
- Tierson, F. D., Olsen, C. L., & Hook, E. B. (1985). Influence of cravings and aversions on diet in pregnancy. *Ecology of Food and Nutrition*, *17*(2), 117-129.
- Tovar, A, Must, A, Bermudez, O.I., H, Raymond R., & Chasan-Tabe, L. (2009). The impact of gestational weight gain and diet on abnormal glucose tolerance during pregnancy in Hispanic women *Maternal and Child Health Journal*, *13*(4), 520-530.
- Tsenkova, Vera, Boylan, Jenifer Morozink, & Ryff, Carol. (2013). Stress eating and health. Findings from MIDUS, a national study of US adults. *Appetite*, *69*(0), 151-155. doi: <http://dx.doi.org/10.1016/j.appet.2013.05.020>
- Uher, Rudolf, Payne, Jennifer L., Pavlova, Barbara, & Perlis, Roy H. (2014). Major Depressive Disorders in DSM-5: Implications for clinical practice and research of changes from DSM-IV. *Depression and Anxiety*, *31*(6), 459-471. doi: 10.1002/da.22217
- Uusitalo, Ulla, Arkkola, Tuula, Ovaskainen, Marja-Leena, Kronberg-Kippilä, Carina, Kenward, Mike G, Veijola, Riitta, . . . Virtanen, Suvi M. (2009). Unhealthy dietary patterns are associated with weight gain during pregnancy among Finnish women. *Public Health Nutrition*, *12*(12), 2392-2399. doi: doi:10.1017/S136898000900528X
- Van Gucht, D., Baeyens, F., Vansteenwegen, D., Hermans, D., & Beckers, T. . (2010). Counterconditioning reduces cue-induced craving and actual cue-elicited consumption. *Emotion*, *10*(5). doi: 10.1037/a0019463
- Vesco, Kimberly K., Dietz, Patricia M., Rizzo, Joanne, Stevens, Victor J., Perrin, Nancy A., Bachman, Donald J., . . . Hornbrook, Mark C. (2009). Excessive gestational weight gain and postpartum weight retention among obese women. *Obstetrics and Gynecology*, *114*(5). doi: 1069-1075 10.1097/AOG.0b013e3181baeacf
- Villamor, E., & Cnattingius, S. (2006). Interpregnancy weight change and risk of adverse pregnancy outcomes: A population-based study. *Lancet*, *368*, 1164-1170.
- Walker, Lorraine O, Hoke, Mary, & Brown, Adama. (2009). Risk factors for excessive or inadequate gestational weight gain among Hispanic Women in a U.S.-Mexico Border State. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *38*(4), 418-429.

- Walker, Lorraine O., Fowles, Eileen R., & Sterling, Bobbie Sue. (2011). The distribution of weight-related risks among low-income women during the first postpartum year. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, 40(2), 198-205. doi: 10.1111/j.1552-6909.2011.01231.x
- Wallace¹, Jacqueline M, Bhattacharya, Sohinee, Campbell, Doris M, & Horgan, Graham W. (2014). Interventions designed to limit gestational weight gain: A systematic review of theory and meta-analysis of intervention components. *BMC Pregnancy and Childbirth*, 14(40). doi: 10.1186/1471-2393-14-40
- Webb, Jennifer B., Siega-Riz, Anna M., & Dole, Nancy. (2009). Psychosocial determinants of adequacy of gestational weight gain. *Obesity*, 17(2), 300-309.
- Weigel, M. Margaret, Coe, Kathryn, Castro, Nancy P., Caiza, Maria Elena, Tello, Nora, & Reyes, Monica. (2011). Food aversions and cravings during early pregnancy: Association with nausea and vomiting. *Ecology of Food and Nutrition*, 50(3), 197-214. doi: 10.1080/03670244.2011.568906
- Weisman, Carol S., Hillemeier, Marianne M., Symons Downs, Danielle, Chuang, Cynthia H., & Dyer, Anne-Marie. (2010). Preconception predictors of weight gain during pregnancy: Prospective findings from the Central Pennsylvania Women's Health Study. *Women's Health Issues*, 20(2), 126-132. doi: doi: 10.1016/j.whi.2009.12.002
- Wells, Chris, Schwalberg, Renee, Noonan, Gretchen, & Gabor, Vivian. (2006). Factors influencing inadequate and excessive weight gain in pregnancy: Colorado, 2000-2002. *Maternal and Child Health Journal*, 10(1), 55-62. doi: 10.1007/s10995-005-0034-2
- Wen, Li M., Rissel, Chris, Simpson, Judy M., Lee, Eric, & Baur, Louise A. (2011). Maternal smoking, weight status and dietary behaviours during pregnancy: Findings from first-time mothers in south-west Sydney, Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 51(1), 31-37. doi: 10.1111/j.1479-828X.2010.01259.x
- White, MA, Whisenhunt, B, Williamson, n DA, Greenway, FL, & Netemeyer, RG. (2002). Development and validation of the food-craving inventory. *Obesity Research*, 10, 107.
- Whiteman, Valerie, Aliyu, Muktar, August, Euna, McIntosh, Cheri, Duan, Jingyi, Alio, Amina, & Salihu, Hamisu. (2011). Changes in prepregnancy body mass index between pregnancies and risk of gestational and type 2 diabetes. *Archives of Gynecology and Obstetrics*, 284(1), 235-240. doi: 10.1007/s00404-011-1917-7
- Williams, Gareth, Bing, Chen, Cai, Xue J., Harrold, Joanne A., King, Peter J., & Liu, Xiao H. (2001). The hypothalamus and the control of energy homeostasis: Different circuits, different purposes. *Physiology & Behavior*, 74(4-5), 683-701. doi: 10.1016/S0031-9384(01)00612-6

- Woods, Sarah M., Melville, Jennifer L., Guo, Yuqing, Fan, Ming-Yu, & Gavin, Amelia. (2010). Psychosocial stress during pregnancy. *American Journal of Obstetrics and Gynecology*, 202(1), 61.e61-61.e67.
- Worthington-Roberts, Bonnie, Little, Ruth E., Lambert, M. Dow , & Wu, Rui (1989). Dietary cravings and aversions in the postpartum period. *Journal of the American Dietetic Association* 89(5), 647.
- Wright, C1, Bilder, D, DeBlasis, T, Mogul, M, Rubin, D, & Shea, JA. (2013). Psychosocial factors associated with gestational weight gain in a low-income cohort. *Journal of Health Care for the Poor and Underserved*, 24(1), 332-343. doi: 10.1353/hpu.2013.0004.
- Wrotniak, Brian H., Shults, Justine, Butts, Samantha, & Stettler, Nicolas. (2008). Gestational weight gain and risk of overweight in the offspring at age 7 y in a multicenter, multiethnic cohort study. *American Journal of Clinical Nutrition*, 87(6), 1818-1824.
- Zhu, Peng, Huang, Wen, Hao, Jia-Hu, Huang, Kun, Jiang, Xiao-Min, & Tao, Fang-Biao. (2013). Time-specific effect of prenatal stressful life events on gestational weight gain. *International Journal of Gynecology & Obstetrics*, 122(3), 207-211. doi: <http://dx.doi.org/10.1016/j.ijgo.2013.04.007>