Cravings and gestational weight gain: predictors of weight-related health in pregnancy and the postpartum

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CRAVINGS AND GESTATIONAL WEIGHT GAIN:
PREDICTORS OF WEIGHT-RELATED HEALTH IN PREGNANCY AND THE POST-
PARTUM

by

Natalia C. Orloff

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Abstract

More than half of all pregnancies result in excess gestational weight gain (GWG), which is one of the most common high-risk obstetric conditions and is associated with health complications in the mother and the fetus. We have conceptualized excess GWG within the Elaboration Intrusion framework and developed studies to test this theory and identify predictors of excess GWG. These studies sought to 1) establish the appropriateness of existing measures related to the constructs of the EI Theory, 2) establish a causal effect of food craving on excess GWG, 3) examine the role of knowledge as a predictor in excess GWG, and 4) explore the type, frequency, and impact of cravings during the post-partum. Pregnant women were recruited from a local academic medical center (n = 84) and online (n = 184). A comparison convenience sample was recruited from a large Northeastern University (n = 626) for use in Study 3. Pregnant women completed the Dutch Eating Behavior Questionnaire (DEBQ), a measure assessing emotional eating, external eating, and restrained eating, the Food Craving Inventory (FCI), which quantifies “frequency” of cravings for specific foods and the likelihood of “giving in” to these cravings, and the Food Cravings Questionnaire-Trait (FCQ-T), a measure of general food craving. We did not replicate the three-factor structure of the FCI or the four-factor structure of the DEBQ in our sample. We did find that specific food cravings accounted for 46.7% of the variance in excess GWG in our full sample and 48.1% of the variance in those that reported a pre-pregnancy BMI in the overweight/obese range. The FCQ-T accounted for 49.9% and 76.0% of the variance in these samples, respectively. While our pregnant sample demonstrated more knowledge regarding appropriate weight gain and caloric intake compared to our convenience sample, their answers were significantly different from published guidelines and were not associated with excess GWG. We also demonstrated stability of craving type and frequency throughout pregnancy and into the post-partum; however, a
relationship between post-partum cravings and excess weight retention was not indicated. Findings have important implications for treatment development targeting cravings in pregnancy and the post-partum.

Keywords: Pregnancy, Cravings, Gestational Weight Gain
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CRAVINGS AND GESTATIONAL WEIGHT GAIN:
PREDICTORS OF WEIGHT-RELATED HEALTH IN PREGNANCY AND THE POST-PARTUM

Introduction
Excess gestational weight gain is a significant problem in the United States, with research showing that half of all pregnancies result in weight gain that exceeds the Institute of Medicines (IOM) guidelines (Oken, Taveras, Kleinman, Rich-Edwards, & Gillman, 2007; Rasmussen & Yaktine, 2009; Wrotniak, Shults, Butts, & Stettler, 2008). Current guidelines state that weight gain of over 35 pounds in women of normal pre-pregnancy weight, 25 pounds in overweight women, and more than 20 pounds in obese women is considered excess (Rasmussen & Yaktine, 2009). Some prenatal weight gain is attributable to the pregnancy itself and includes the weight of the fetus, placenta, and amniotic fluid, however, a large portion of the variance in weight gain is accounted for by an increase in fat mass (Rasmussen & Yaktine, 2009).

Food cravings are strong urges for specific foods and have been shown to be positively associated with energy intake and body mass in non-pregnant populations. Food cravings are commonly reported by pregnant women and there is at least preliminary evidence to suggest that excess gestational weight gain may be due to an increase in caloric intake secondary to an intensification in food cravings during pregnancy. However, this issue remains heavily understudied, with limited research seeking to examine craving type, frequency, and intensity as a risk factor for weight gain in pregnancy. There are several reasons that may account for a relative lack of research on pregnancy cravings, including a poor understanding of the etiology of food craving and a lack of appropriate measures to quantify craving during this time-period. These gaps in the literature are striking given the prevalence of excess gestational weight gain
and the well documented complications that are attributable to excess weight gain both during and after pregnancy and for both the mother and the fetus. Current interventions targeting excess gestational weight gain by modifying diet and/or physical activity have shown limited promise. Identifying risk factors for excess gestational weight gain, such as cravings, could lay the foundation for the development of novel, more effective interventions.

**Background**

**Gestational Weight Gain**

The National Research Council and the IOM report that between 1990 and 2003 there was a 20 - 25% increase in women gaining more than 40 pounds during pregnancy in the United States (Dalenius, Brindley, Smith, Reinold, & Gummer-Strawn, 2012). There is concern that this increase disproportionately affects women who were already overweight or obese pre-pregnancy, with the Center of Disease Control Pregnancy Nutrition Report showing that from 2001 to 2010, 58.8% and 55.6% of overweight and obese women had excessive gestational weight gain. Excessive weight gain during pregnancy is also an issue for normal or underweight women, with 38.6% and 26.2% of these women gaining excess weight, respectively (Dalenius et al., 2012).

Insufficient weight gain during pregnancy is known to have serious health effects on the health and growth of the fetus, such as greater risk for preterm birth and low birth weight (Ehrenberg, Dierker, Milluzzi, & Mercer, 2003; Han, Mulla, Beyene, Liao, & McDonald, 2011). Excessive weight gain, on the other hand, can also have detrimental effects, perhaps beyond the risk associated with insufficient weight gain. The adverse effects of excess gestational weight gain are significant not only during pregnancy, but also during delivery, and well into the post-partum. Moreover, excess weight adversely affects both the mother and the offspring. It is considered one of the most common high-risk obstetric conditions, leading to higher rates of
cesarean sections and an associated increase in the cost for obstetric care (Galtier-Dereure, Boegner, & Bringer, 2000; Stotland, Hopkins, & Caughey, 2004; Vahratian, Siega-Riz, Savitz, & Zhang, 2005). Additionally, it is associated with a substantially elevated risk of hypertension, gestational diabetes, preeclampsia, perinatal fatality, neural tube defects, and neonatal hypoglycemia during pregnancy (American Dietetic Association (ADA), 2002; Galtier-Dereure, et al., 2000; Hilson, Rasmussen, & Kjolhede, 1997, 2006; Thorsdottir, Torfadottir, Birgisdottir, & Geirsson, 2002). Evidence also indicates that failure to initiate breastfeeding is associated with excessive weight gain during pregnancy (Hilson et al., 1997, 2006). Beyond complications during pregnancy, the offspring’s health may also be compromised, such that excess gestational weight gain is linked to macrosomia and overweight and obesity in children (ADA, 2002; Oken et al., 2007; Stotland et al., 2004; Wrotniak et al., 2008). Mothers who gain excess weight are at greater risk for retaining weight after pregnancy and it is predictive of overweight or obesity later in life (Hilson et al., 1997, 2006; Rooney, Schaubberger, & Mathiason, 2005; Thorsdottir et al., 2002).

The consequences of excess gestational weight gain are well established, however, the risk factors associated with unhealthy weight gain in pregnancy remain to be elucidated. Research has indicated that risk factors can be physiological, sociocultural, or psychological. For example, insulin sensitivity and basal metabolic rate are hypothesized predictors of excess weight gain (Rasmussen & Yaktine, 2009). In addition, there is a growing body of literature to suggest that depression and anxiety may have an adverse impact on maternal and fetal health indirectly via effects on eating behavior. For example, the presence of psychosocial stressors like anxious or depressed mood in pregnancy adversely affects dietary quality by increasing macronutrient consumption and decreasing micronutrient intake (Hurley, Caulfield, Sacco,
Increased body weight and shape concern and disordered eating during pregnancy is associated with postnatal depression (Abraham, Taylor & Conti, 2001). Moreover, race/ethnicity, education level, age at time of pregnancy, lack of access to exercise space, and food insecurity are variables indicated to account for at least some portion of the variance in weight gain, though, the correlations are generally weak (Chu, Callaghan, Bish, & D’Angelo, 2009; Olson & Strawderman, 2008). Given the lack of substantial evidence identifying risk factors for excess gestational weight gain, the Institute of Medicine has made a call for research to pinpoint potential predictors (Rasmussen & Yaktine, 2009).

**Food Cravings**

The occurrence of food cravings in the United States is common, with 68% - 97% of college-age individuals reporting ever having experienced a craving for a specific type of food (Weingarten & Elston, 1990; Zellner, Garriga-Trillo, Rohm, Centeno, & Parker, 1999). Relative to urges for other substances, such as alcohol and cocaine, and problem behaviors, such as pathological gambling, craving for food is generally thought of as being relatively benign (Bottlender & Soyka, 2004; Evren, Durkaya, Evren, Dalbudak, & Cetin, 2012; Ferguson & Shiffman, 2009; Sinha, Garcia, Paliwal, Kreek, & Rounsaville, 2006). Yet, recent research indicates that food craving may be linked to a number of eating- and weight-related pathologies, including overweight and obesity, bulimia nervosa, binge eating, and failure to achieve and sustain weight loss (Forman et al., 2007; Gendall, Joyce, & Sullivan, 1997; Lafay et al., 2001; Lowe, 2003; Lowe & Levine, 2005; Vander Wal, Johnston, & Dhurandhar, 2007). In clinical samples, food cravings appear to be triggers for episodes of binge eating (Bjoervell, Roennberg, & Roessner, 1985; Kales, 1990). Research targeting craving has increased (Alberts, Mulkins,
Smeets, & Thewissen, 2010; Forman et al., 2007; Meule & Kübler, 2012), however, our understanding of the etiology of craving is limited.

Craving is a construct recognized in the United States, though its significance in non-western cultures is not only understudied, but may also be limited with research showing a lack of fully equivalent translations for the word in non-English languages (Hormes, 2014; Hormes & Rozin, 2010). The most commonly reported food craving in the United States is for chocolate (Osman & Sobal, 2006; Rozin, Levine, & Stoess, 1991); however, type, frequency, and intensity of food cravings tend to vary based on demographic characteristics (Pelchat, 1997; Zellner et al., 1999, Zellner, Saito, & Gonzalez, 2007). Differences by age and gender have been reported, with younger individuals reporting higher frequency of cravings (Pelchat, 1997), and women generally reporting stronger urges for sweets as compared to men, who commonly report cravings for savory foods (Zellner et al., 1999, 2007). The gender differences in frequency and type of craving can be accounted for, primarily, by an association between craving and female reproductive states: research documents a marked increase in chocolate craving during the perimenstrum, which begins four days prior to menstruation and continuing through the cycle (Hormes & Rozin, 2009; Rozin et al., 1991; Zellner, Garriga-Trillo, Centeno, & Wadsworth, 2004), and an overall increase in food craving frequency and intensity during pregnancy (Pope, Skinner, & Carruth, 1992).

**Proposed model.** Craving for chocolate has been endorsed by 90% of women in America (Osman & Sobal, 2006), with 45% reporting regular chocolate craving (Zellner et al., 1999). Half of cravings for chocolate reportedly occur perimenstrually (Rozin et al., 1991; Zellner et al., 2004), with a marked increase a few days before the onset of menstruation and continuing into the first few days of menses. In the perimenstrum literature two overarching types of theories
have emerged, one suggesting that biochemical and physiological factors are primary in craving etiology, and one proposing a causal role of contextual and psychosocial mechanisms. Regarding biochemical and physiological factors, hypotheses have pointed to the role of ovarian hormone levels, nutritional deficits during the perimenstrum, and the palliative nature of pharmacological ingredients in chocolate and other craved foods. Empirical evidence generally fails to support these hypotheses (Hormes, 2014). Regarding the latter theories, research has begun to identify potential cultural and psychosocial factors that may be underlying craving during this – and potentially other - times.

The Elaboration Intrusion (EI) Theory of desire conceptualizes craving as a largely cognitively motivated state (Kavanagh, Andrade, & May, 2005). It hypothesizes that craving is caused by the activation of two sequential processes: 1. the associative and largely automatic processes that trigger intrusive thoughts about an appetitive target, and 2. the active cognitive elaboration of these intrusive thoughts that maintains and strengthen their salience. Intrusive thoughts are triggered via various learned associations, such as physiological deficit states, negative affect, external cues, other cognitive activity, or anticipatory responses to the target. In the case of food craving, the associative process is thought to occur in response to conditioned internal (e.g., boredom or low mood) or external (e.g., walking by a bakery) cues. Automatic thoughts are especially likely to occur when cognitive load is low. Kavanagh points out that if this initial associative process elicits powerful affective reactions, then individuals will engage in elaboration. During the elaboration process, the intrusive thoughts are not only attended to, but also elaborated on. This can lead to the individual seeking out relevant information, internal stimuli, or external stimuli.
Many commonly craved foods are highly palatable and calorically dense. For example, chocolate contains a unique mix of fat and sugar, making it an innately desirable food for humans. At the same time, our society vilifies many of these foods as “unhealthy,” “taboo, or “forbidden.” Hormes’ (2014) posited model of craving suggests that due to the simultaneous appealing and forbidden nature of palpable foods, women are faced with competing approach (“I want it”) and avoidance tendencies (“I can’t have it”). In the context of EI Theory, this conflict – also termed ambivalence – facilitates elaboration of automatic thoughts about craving targets and serves to maintain and strengthen craving episodes. In an attempt to resolve the conflict between approach and avoidance U.S. women tend to resort to abstinence, which paradoxically increases the craving for such foods.

Theories invoking physiological mechanisms in the etiology of food cravings during the perimenstrum and pregnancy have received limited empirical support. We hypothesize that these female reproductive states are conceptualized by our culture as acceptable excuses for women to indulge in otherwise forbidden foods, resulting in increased endorsement of cravings during those times. Our review of the published literature on this subject generally supports the applicability of this theoretical framework of craving etiology specifically in pregnancy (Orloff & Hormes, 2014).

Hormones. Rodin and colleagues (1991) found that despite early literature indicating a possible relationship between fluctuating levels of hormones and craving during the perimenstrum, a direct link between the two was unfounded (Rodin, Mancuso, Granger, & Nelbach, 1991). Research has expanded on this by showing a lack of reduction in cravings during the perimenstrum when progesterone was administered to prevent the natural drop-off in ovarian hormones prior to the onset of menstruation (Michener, Rozin, Freeman, & Gale, 1999).
A direct relationship between hormones and craving remains to be elucidated in the pregnancy literature. However, indirectly there is support for a role of alterations in sensory perception in craving etiology, perhaps due to changing levels of hormones (Kuga, Ikeda, Suzuki, & Takeuchi, 2002; Nordin, Broman, Olofsson, & Wulff, 2004). An increase in taste and olfactory sensitivity may change food preferences and patterns of consumption in pregnancy. Early theories suggest that the “morning sickness” characteristic of pregnancy may serve the evolutionarily adaptive purpose of decreasing the consumption of substances that can be toxic to a developing fetus (Profet, 1992). It seems reasonable to assume that cravings may serve a similarly adaptive function of increasing the consumption of foods beneficial to expecting mothers and/or the developing fetus. Evidence does point to substantial prenatal changes in dietary habits, with 26% and 65.4% of women reporting changes in their taste and olfactory perception during pregnancy (Nordin et al., 2004), and 75% of women reporting a change in their eating habits during pregnancy (Cantoni, Hudson, Distel, & Laska, 1999). The parallels between changes in sensory perception and the trajectory of increasing cravings (Kuga et al., 2002) suggest a potential link; however, research has yet to clarify this relationship.

**Nutritional deficits.** It is an unequivocal fact that menstruation can cause a decrease in the availability of certain nutrients, such as iron due to blood loss (Harvey et al., 2005); however, it is unlikely that these deficits play a role in the most common perimenstrual cravings given that the ingredients in chocolate would not be a sufficient replacement. A stronger argument for the role of craving to fulfill nutritional deficits would be if women endorsed craving for foods such as red meat, egg yolks, or leafy greens during menstruation, all of which provide larger amounts of iron than chocolate (Hormes, 2014; Pelchat & Schaeffer, 2000).
Applying this hypothesis to pregnancy would suggest that the emergence of cravings is due to a need for additional nutrients. It is an undeniable fact that there are added demands on the mother during fetal growth and that proper nutrition is necessary for a healthy pregnancy (King, 2000), with the possibility of inadequate placental and fetal growth if there is not proper nutrition (Allen, 2000; Kaiser & Allen, 2002). Given the importance of nutrients, guidelines are in place to highlight and promote the intake of certain micronutrients, such as iron, folic acid, B vitamins, zinc, magnesium, iodine, vitamin A, and calcium (Kaiser & Allen, 2002). Thus, the nutritional deficits hypothesis postulates that food cravings are in response to a need for nutrients to ensure proper fetal growth (Tierson, Olsen, & Hook, 1985). Foods that meet these nutritional needs include leafy greens, legumes, beans and lentils, and unrefined grains. However, cravings commonly reported by pregnant women primarily include sweets, high-fat foods, and fast foods (Flaxman & Sherman, 2000; Flesser, 2002; Kaiser & Allen, 2002). Findings from a pilot study conducted by our lab corroborated the research showing that pregnant women commonly report cravings for high-calorie, sugary, and fatty foods.¹

Like craving for chocolate during the perimenstrum, the foods reportedly craved by women during pregnancy do not contain ingredients suitable to fulfill the nutrient needs that are hypothesized to arise during gestation. Moreover, foods that would increase the required nutrients are often reported as aversions during pregnancy, like meat and other high-protein foods (Bayley, Dye, Jones, DeBono, & Hill 2002; Hook, 1978; King, 2000; Pope et al., 1992). These findings provide little support for the hypothesis that cravings during pregnancy are in response to nutritional deficits. This argument is further supported by research showing that

¹ Preliminary data was collected by surveying online blog posts and message boards that included topics related to craving in pregnancy. An N = 200 posts were sampled, of them the top three endorsed cravings in descending order include “Sweets,” “Carbohydrates, high-calorie, savory foods,” and “Animal protein.”
cravings tend to appear during the early stages of pregnancy, whereas fetal growth – and any associated nutritional needs – accelerates during the later stages of pregnancy (King, 2000).

**Pharmacologically active ingredients.** Many women experience a number of physiological symptoms around the onset of menstruation, such as cramps, bloating, and fatigue (Bruinsma & Taren, 1999). Research has posited that craving for chocolate is a response to these symptoms, such that the pharmacological ingredients in chocolate alleviate the physiological symptoms (Hormes, 2014). Chocolate contains a number of potentially psychoactive ingredients, including the methylxanthines, a group of compounds, which can have energizing effects. However, there is not enough of this or similar compounds in a normal serving size of chocolate to have any noticeable palliative effects in the average consumer (Hormes, 2014; Mumford et al., 1994). Moreover, studies have indicated that variants of chocolate that do not contain any of the hypothesized active ingredients can be more effective at alleviating cravings than capsulated cocoa power, which contains the active ingredients (Michener & Rozin, 1994). Thus, the literature does not seem to support the hypothesis that craving during the perimenstrum is a response to physiological symptoms.

Pregnancy brings upon a number of physiological symptoms, such as nausea, vomiting, and aversions to specific foods. Cravings during pregnancy, like during the perimenstrum, have been speculated to occur as a way to increase the consumption of foods that can have an analgesic effect on the physiological symptoms (Bayley et al., 2002). The literature provides minimal support for this research, with findings showing that food aversions and cravings infrequently co-occur (Bayley et al., 2002), and that aversions typically precede the development of cravings (Bayley et al., 2002; Tierson et al., 1985). In some cases, the development of craving may not emerge until weeks after the onset of illness, thus the exact nature of the relationship is
unknown (Bayley et al., 2002). The lack of research supporting the temporal nature of aversions and cravings provides little evidence for the hypothesis that cravings during pregnancy emerge to alleviate the physiological symptoms of pregnancy.

**Cultural and psychosocial factors.** The model of craving during the perimenstrum proposed by Hormes (2014) builds upon EI Theory and suggests that sociocultural factors play a significant role in the onset of cravings specifically during the perimenstrum. This hypothesis is supported by a lack of consistency in craving across cultures, with the types, prevalence and temporal patterns of food cravings varying drastically by geographic region. Tradition and culinary tradition appear to have a substantial effect on the type of craving individuals report, such that rice is the most commonly reported craving by women in Japan (Komatsu, 2008), a lower rate of chocolate craving has been reported in Egyptian women (6%) (Parker, Kamel, & Zellner, 2003), and men and women equally endorse craving for chocolate in Spain (Osman & Sobal, 2006). The lack of support for the previous hypotheses illustrates the importance of identifying cognitive and cultural factors in the development of cravings.

Akin to cultural differences in general cravings, there appears to be differences between cultures when it comes to pregnancy cravings, highlighting the possibility of contextual and psychosocial variables as possible etiological factors. While cravings during pregnancy do appear to exist in countries outside of the United States (Bayley et al., 2002, Nyaruhucha, 2009; Obeyesekere, 1963; Patil, 2012; Steinmetz, Abrams, & Young, 2012), data shows differences in the types, meaning, and psychosocial correlates of these cravings. Indo-Ceylon women, for example, report craving for foods that reflect their traditional role as a wife and mother (Obeyesekere, 1963), Nigerian women report craving for nutrient-dense foods, such as fruits,
vegetables, and cereal (Olusanya & Ogundipe, 2009), and Tanzanian women commonly endorse cravings for meat, fish, vegetables, fruit, and grains (Patil, 2012).

The presence of cravings during pregnancy appears to cross cultures; however, the types of cravings reported seem to be culturally bound. Perhaps more importantly, what seems to be culturally specific is the relationship between cravings and gestational weight gain, with research suggesting that the link between cravings and gestational weight gain may be unique to the United States. As previously stated, more than half of all pregnancies in the United States result in weight gain that exceeds recommended guidelines. Compared to 55.6% of obese women and 38.6% of normal weight women gaining in excess in the United States (Dalenius et al., 2012), only 14.5% and 30.4% of obese and normal weight women were reported to gain in excess of 35.3 pounds during pregnancy in Sweden (Cedergren, 2006). Furthermore, only 2.7% of Vietnamese women gained more than 44.1 pounds in pregnancy (Ota et al., 2011), and Hispanic women who spent less than 10 years in the United States had a 50% lower likelihood of gaining excess weight as compared to their more acculturated counterparts (Chasan-Taber et al., 2008).

In line with Kavanagh (2005) and Hormes’ (2014) respective models, it is suggested that ambivalence towards highly palpable foods increases the craving for the food, and just like the perimenstrum, pregnancy can provide a socially sanctioned excuse needed to reduce the guilt or ambivalence of giving in to the craving and consuming the desired food. This is supported by the widespread belief that pregnancy means “eating for two,” and that doing so is consistent with being a good mother (Copelton, 2007). Interestingly, craving in the general population is often

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2 Of note, there are marked differences in guidelines for gestational weight gain (GWG) in different countries; however, 13 of 22 countries surveyed used guidelines similar to the IOM. Parts of Western Europe recommend GWG in the lower end of the IOM suggestions (10-15 kg or 22-33 lbs). In India and Africa (8-10 kg or 17.6-22 lbs.), the Philippines (11-12.5 kg or 24.3-27.6 lbs.), and Chile (12-13 kg or 26.5-28.7 lbs.), official guidelines all suggest significantly lower weight gains for a normal weight expectant mother, compared to the thresholds recommended by the IOM (Alavi, Haley, Chow, & McDonald, 2013).
associated with conflicting approach-avoidance thoughts and behaviors (Cartwright & Stritzke, 2008; Hormes & Rozin, 2011; Macdiarmid & Hetherington, 1995); however, in the pilot study conducted by our lab only 6.1% reported negative affect in relation to their pregnancy cravings and only 4.5% reported efforts to resist these cravings. These findings provide some evidence for the notion that sociocultural views about craving during pregnancy may account for some of the variance.

In line with research suggesting that perimenstrual cravings are especially pronounced in individuals with eating pathology (Hormes & Timko, 2011), disordered eating is an additional hypothesized factor that may underlie the presence of food cravings during pregnancy. Early studies proposed that a history of being a “picky eater,” high levels of food faddiness, and stress-induced appetite changes were significant predictors of food cravings and aversions during pregnancy (Dickens & Trethowan, 1971). Perhaps the most interesting findings regarding eating pathology and weight gain during pregnancy show that Caucasian women who were deemed restrained eaters, as evidenced by frequently thinking about their diet and weight and making multiple attempts to restrict their intake, were significantly more likely to exceed gestational weight guidelines (Conway, Reddy, & Davies, 1999). Similarly, dieters were found to endorse more episodes of overeating during pregnancy as compared to non-dieters (Fairburn & Welch, 1990). Interestingly the findings relating restrained eating and excess weight gain during pregnancy only hold in a Caucasian population, further driving the importance of culture on gestational weight gain (Allison, Wrotniak, Pare, & Sarwer, 2012). It is hypothesized that the culturally sanctioned excuse for consumption of taboo foods during pregnancy may act as a catalyst for disinhibited eating in restrained eaters.
Culture-specific norms and beliefs appear to be accounting for a portion of the variance in pregnancy cravings. It is hypothesized that cravings are not only encouraged during pregnancy by social norms, but are present at a higher frequency in women who experience the approach-avoidant attitude towards taboo foods prenatally. These conditions may lead women to be more susceptible to overconsumption of the craved, high calorie food, resulting in excess weight gain. Moreover, cravings are presumed to be a specific risk factor for women with high levels of prenatal restrained eating and other pathological eating behaviors. Based on the EI theory of desires, we posit that having pre-morbid disordered eating thoughts has a direct and influential effect on the elaboration process, ultimately increasing the salience of craving thoughts and helping maintain the craving episode.

The lack of support for any one hypothesis of pregnancy craving etiology suggests that there are a number of gaps in the literature, which need to be addressed before being able to draw definite conclusions about predictors of gestational weight gain. Existing measures are well validated for capturing general and specific cravings (Cepeda-Benito, Gleaves, Williams, & Erath, 2000; White, Whisenhurst, Williamson, Greenway, & Netemeyer, 2002), however, there are several differences between pregnancy and non-pregnancy cravings. For example, non-pregnant women primarily report strong urges to consume sweets (Zellner et al., 1999), while pregnant women endorse cravings for sweets, as well as dairy, carbohydrates, fruits, vegetables, and fast food (Hook, 1978; Flaxman & Sherman, 2000; King, 2000). Thus, a validation of existing food related measures is warranted to address the appropriateness of their use in an expecting population. Preliminary data has identified that in a cross-sectional design, both “frequency” of and “giving in” to cravings account for a significant portion of the variance in gestational weight gain (Orloff et al., 2016). Results from early studies show that the amount of
variance accounted for differed based on demographics, with women who were classified as overweight or obese being more at risk for excess gestational weight gain (Anderson et al., 2015; Orloff et al., 2016). A longitudinal design is required to examine if there is a causal effect between food cravings and gestational weight gain. Additional hypotheses about gestational weight gain suggest that women are exceeding guidelines due to a lack of knowledge about nutrition and weight gain. However, research in this area is in its infancy and requires further examination. Finally, there is a dearth in literature looking at these hypothesized predictors and their role after delivery, thus updated research should identify to what extent craving plays a role in diet- and weight-related health in the peri- and post-partum. Filling the gaps in literature will allow for the identification of targets for intervention to decrease the incidence of excess gestational weight gain in the United States.

Participants and Procedures

All methods were approved by the Institutional Review Boards at Albany Medical Center and the University at Albany, State University of New York. Respondents from each sample were informed of the nature and purpose of the study and consented prior to participation.

The studies presented here draw from three different populations. Demographics for each sample are detailed below and in Table 1. Please refer to Table 2 for pregnancy information for the hospital and online samples.

**Hospital Sample.** A sample of women were recruited from a local hospital’s Department of Obstetrics, Gynecology, and Reproductive Services to examine cravings and their impact on weight in pregnancy and the post-partum longitudinally. Women receiving routine prenatal services were given a flyer with information about the nature of the study. If a patient indicated interest in the study, her contact information was collected and given to study
personnel who contacted the patient via phone or email to schedule a meeting to coincide with a routine medical visit. Inclusion criteria included being at least 18 years of age, fluent in English reading and writing, and currently pregnant. Women were eligible to complete the survey up to four times (first, second, and third trimester, as well as during the post-partum). All women were given the option to complete the questionnaire at the office on a provided tablet or from home on a computer, tablet, or other mobile device, after being provided a link to the survey. The same interface was used regardless of location of completion. Women were compensated with a $15.00 gift card to a local retailer for each completed time point, for a possible total compensation of $60.00.

Of the original sample of women recruited from the local medical center who completed time point one \( (n = 84) \), 35.7% \( (n = 30) \) completed time point two, 6.0% \( (n = 5) \) completed time point three, and 39.3% \( (n = 33) \) completed the post-partum questionnaire. Women identified as White \( (n = 45, 53.6\%) \), Black/African American \( (n = 22, 26.2\%) \), Hispanic/Latino \( (n = 6, 7.1\%) \), Asian \( (n = 6, 7.1\%) \), or other \( (n = 5, 6.0\%) \). Average age of the sample was 29.88 years \( (SD = 5.66) \). At time point one, over half of the sample was married \( (54.8%, n = 46) \), 25.0% \( (n = 21) \) were living with a partner, 19.0% \( (n = 16) \) were single, and 2.4% \( (n = 2) \) were separated, divorced, or widowed. More than 60% of the sample \( (60.5%, n = 49) \) reported a household annual income less than $50,000 and 63.8% reported an individual annual income of less than $30,000. The majority of the sample \( (75.0%, n = 63) \) completed at least some college.

Women reported an average body mass index (BMI) of 30.65kg/m² \( (SD = 11.19) \) prior to the onset of pregnancy. Of those that provided pre-pregnancy weights, 3.7% \( (n = 3) \) reported body mass indices in the underweight range, 33.3% \( (n = 27) \) were in the normal range, 21.0% \( (n = 17) \) were in the overweight range, 42.0% \( (n = 34) \) were in the obese range. Most women
reported having been pregnant in the past (75.0%, \( n = 63 \)). Weeks’ gestation at the time of consent ranged from eight to 38 weeks (\( M = 22.82, SD = 8.66 \)). Half the sample reported being in their second trimester (50.0%, \( n = 42 \)), 32.1% (\( n = 27 \)) were in their third trimester, and the remaining 17.9% (\( n = 15 \)) were in their first trimester. At the time of consent, all women reported having a singleton pregnancy. The majority of women (86.9%, \( n = 73 \)) gave consent for their medical records to be reviewed following delivery. Review of the medical records revealed that one respondent (1.2%) was pregnant with multiples and one woman had experienced a miscarriage. These two participants were excluded from the analyses presented here.

**Online Sample.** A second sample of pregnant women (\( n = 184 \)) was recruited via posts to online websites targeting pregnant women (i.e., Café Mom Group, Baby Bump message board, Birth Watch Facebook page, etc.) to increase our sample size in the analysis of the psychometric properties of key measures of food craving and related eating behaviors. A link to the survey was provided on the websites and redirected participants to the secure online survey collection website, Survey Monkey. Inclusion criterion included being 18 or older, fluent in English reading and writing, and currently pregnant. Women were informed of the nature of the study and were consented remotely before completing the survey. Participants completed one of two short questionnaires; given the limitations of online data collection and lack of reimbursement for anonymous survey completion, the length of the questionnaires was considerably reduced from the version completed by the participants recruited at the hospital. Time to complete the online battery ranged from five to 15 minutes, depending on version.

Over two thirds of the women identified as White (\( n = 122, 66.3\% \)). Other race/ethnicities were significantly under-represented in those that completed this information: Black/African American (\( n = 1, 0.5\% \)), Hispanic/Latino (\( n = 1, 0.5\% \)), Asian (\( n = 12, 6.5\% \), and
other ($n = 4, 2.2\%)$. Average age of the sample was 30.60 years ($SD = 4.45$). Of those that provided information, about half of the sample ($51.6\%, n = 47$) reported a household annual income greater than $110,000.

Women reported an average BMI of 25.08 kg/m$^2$ ($SD = 6.42$). A small percentage of women reported a BMI in the underweight range ($6.8\%, n = 9$). Over half the sample reported a BMI in the normal range ($53.4\%, n = 71$). The remainder of the sample reported a BMI in the overweight ($26.3\%, n = 35$) or obese ($13.5\%, n = 18$) range. Weeks’ gestation at the time of consent ranged from one week to 41 weeks ($M = 23.32, SD = 10.05$). For those that provided information, $48.1\% (n = 62)$ reported being in their second trimester, $40.3\% (n = 52)$ were in their third trimester, and the remaining $11.6\% (n = 15)$ were in their first trimester. All but five respondents ($3.6\%)$ reported having a singleton pregnancy ($96.4\%, n = 133$).

**Undergraduate Sample.** To compare pregnant respondents to non-pregnant controls, a sample of undergraduate students at a large Northeastern university ($n = 626$) completed measures of interest to the current project in the context of a larger cross-sectional study identifying various factors related to craving, consumption, and avoidance of food. All participants received course credit in exchange for their completion of the study. Inclusion criteria included reading and writing fluency in English. The surveys were accessible through the online service Survey Monkey.

The majority of the undergraduate sample were freshmen ($59.1\%, n = 367$), with the number of participants decreasing in each subsequent year of school (sophomore $25.0\%, n = 155$; junior $12.2\%, n = 76$, senior $3.4\%, n = 21$). The sample was split relatively evenly in terms of sex, with $50.5\% (n = 314)$ identifying as female, $49.2\% (n = 306)$ identifying as male, and $0.3\%$ identifying as “other” ($n = 2$). Average age was 18.83 years ($SD = 1.70$). Average BMI was
24.50 kg/m$^2$ ($SD = 4.15$) for the whole sample. When looking at the different sexes, females and males reported similar average BMIs (females: $M = 24.11$ kg/m$^2$, $SD = 4.07$; males: $M = 24.87$ kg/m$^2$, $SD = 4.16$). The sample was consistent with the universities demographic make-up, with the majority reporting having been born in the United States (84.5%, $n = 528$) and 51.3% ($n = 321$) identifying as White. The remainder of the sample identified as Black/African American (13.6%, $n = 85$), Asian (13.9%, $n = 87$), Hispanic/Latino (11.5%, $n = 72$), and other (9.7%, $n = 61$).
Study 1:
Confirmatory Factor Analysis of the Food Craving Inventory and the Dutch Eating Behavior Questionnaire in Pregnant Women

Introduction

The prevalence of excess gestational weight gain in the United States has been on the rise and in many ways parallels the increase in overall (i.e., non-pregnancy) prevalence of overweight and obesity (Dalenius et al., 2012). There are number of competing hypotheses constructed to explain this increase in the number of women who gain an excessive amount of weight in pregnancy (Orloff & Hormes, 2014). Preliminary data from our cross-sectional study (Orloff et al., 2016), as well as previously published qualitative data (Anderson et al., 2015) point to food cravings as potentially playing a causal role in excess gestational weight gain.

Food cravings are strong urges for foods that are more specific and more intense than general hunger (Gendall et al., 1997; Hormes & Rozin, 2010; Pelchat, 2002). Cravings in pregnancy are a popular topic in our society, with the term “pregnancy craving” searched an estimated 4,400 times by Internet users in the United States in the last month. While food cravings in pregnancy appear to be of popular interest, there is relatively little empirical research looking at the types, frequency, and consequences of food cravings during pregnancy and into the post-partum period. One reason for the present dearth of research in this area may be the lack of measures designed to quantify different aspects of the craving experience that have been shown to be valid and suitable for use specifically in pregnant women.

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3 The search frequency for the term “pregnancy craving” was examined using the Wordtracker application https://www.wordtracker.com. The Wordtracker application searches keywords and identifies the frequency with which individuals in a designated location have conducted online searches for the term over a specific time-period. The search for the term “pregnancy craving” was conducted on 05/05/2018.
Measures have been created to assess both general and specific food cravings. Preliminary assessment tools had many limitations, with perhaps the most important being the lack of psychometric validation. Hill and colleagues used a food-craving record that focused on contextual and sensory cues, feelings, and intensities of hunger in a study looking at the relationship between craving, restrained eating, and mood (Hill, Weaver, & Blundell, 1991). The two instruments, developed by Cepeda-Benito, are widely used and empirically validated craving instruments that assess craving as a situational state (Food Cravings Questionnaire – State) and as a stable trait (Food Cravings Questionnaire – Trait) (Cepeda-Benito et al., 2000). One of the early measures of specific food cravings grouped cravings based on macronutrient content (i.e., low-fat proteins, complex carbohydrates) however, no psychometric analyses were conducted (Harvey, Wing, & Mullen, 1993). Thus, the Food Craving Inventory (FCI) was created as an empirically validated measure of specific food cravings (White et al., 2002). In the development of the FCI, the authors considered both the subjective and behavioral report of craving, aiming to account for both the cognitive nature (“frequency” of cravings) and behavioral characteristics (“giving in” to cravings). The measure has the ability to capture whether craving for specific classes of foods with similar macronutrient content co-occur. In addition, the FCI aimed to determine whether the subjective and behavioral reports of craving are psychometrically different constructs.

Findings from the original FCI validation study found that the subjective and behavioral report of cravings were highly correlated. White and colleagues argued that craving is best conceptualized as a single construct. However, they noted that there is value in differentiating between the four correlated dimensions, “high fat foods,” “sweets,” “carbohydrates/starches,” and “fast food fats.” This was based on findings showing differences in the subscale, but not total
scores, between obese and non-obese participants. The FCI was originally validated in a demographically diverse sample, with varying body mass indices, and ages ranging from 16 to 79. The original validation resulted in reliability coefficients falling between 0.76 to 0.93 and test-retest reliability coefficients between 0.79 to 0.91. Given the frequency of food cravings in pregnancy and their potential role in perinatal weight and weight-related health, it is important to evaluate the psychometric properties of the FCI in an expecting population.

In addition to focusing on specific food cravings, we have further conceptualized craving as a cognitively motivated state. As previously stated, EI Theory posits that craving is caused by the activation of two processes, the automatic associative process and the subsequent cognitive elaboration process. We hypothesize that learned associations trigger automatic thoughts about a craved food, which are actively elaborated upon, leading to an increase in intensity of the craving. Emotional eating is eating in response to negative emotional states, such as anger, anxiety, or depression. Conversely, external eating is eating in response to food-related cues in the absence of, or regardless of, internal hunger states (Van Strien, Frijters, Bergers, & Defares, 1986). We believe that emotional and external eating are relevant to how we conceptualize craving within the EI Theory, such that both can trigger automatic thoughts that are then elaborated upon. We further postulate that the elaboration process is influenced by common feelings of ambivalence toward calorically dense foods. Pregnant women who have internalized norms like the need to “eat for two” often relinquish any previous hesitations about consuming “forbidden” or “taboo” foods (Copelton, 2007; Orloff & Hormes, 2014). Researchers have posited that these pre-pregnancy beliefs about food are associated with elevated levels of eating disorder symptomology and overconsumption during pregnancy (Clark & Ogden, 1999; Fairburn & Welch, 1990).
One construct that has consistently been associated with an increase in caloric intake during pregnancy is restrained eating (Conway et al., 1999; Fairburn & Welch, 1990; Mumford, Siega-Riz, Herring, & Evenson, 2008). Restrained eaters are those that frequently think about their diet, weight, and attempt, albeit often failed, to restrict their dietary intake (Van Strien et al., 1986). In a non-pregnant population, dietary restraint can lead to a number of disordered eating behaviors like disinhibited overeating (Ruderman & Wilson, 1979) and binge eating (Ruderman, 1986), and is also implicated in bulimia nervosa (Polivy & Herman, 1985). Regarding the population of interest, Conway and colleagues (1999) found that Caucasian female restrained eaters were significantly more likely than unrestrained eaters to gain an excessive amount of weight during pregnancy. Similarly, pre-pregnancy restrained eating and dieting was a significant predictor of excess weight gain for all women except for those categorized as underweight prior to pregnancy (Mumford et al., 2008). However, these findings were not replicated in an African American sample (Allison et al., 2012). The lack of consistency in findings has been attributed to the lack of reliability of methods used to measure the construct of restrained eating (Williamson et al., 2007).

Van Strien et al. (1986) developed the Dutch Eating Behavior Questionnaire (DEBQ) to fill a gap in validated eating measures related to restrained eating. They argued that the scales available were either not appropriate for non-obese individuals or lacked three factors they considered necessary to explain overindulgence in individuals across the weight spectrum. Our conceptualization of the maintaining mechanism of craving (i.e., the EI Theory of desires; Kavanagh et al., 2005) aligns with the factors assessed in the DEBQ, such that emotional and external eating can trigger the automatic thoughts and high levels of restraint contribute to the elaboration process. However, to our knowledge there have not been any studies validating this
measure in expecting women. Validation in a pregnant sample would provide justification for use of this measure in future research on eating behaviors in pregnancy.

**Study Aims**

The current study aimed to replicate the factor structure of two measures uniquely suited to testing the predictions of EI Theory specifically in pregnancy: the FCI (White et al., 2002), a measure of specific food cravings, and the DEBQ (Van Strien et al., 1986), a measure of “emotional,” “external” and “restrained” eating behavior. The study was designed to determine if the subjective and behavioral report of cravings in an expecting population fits the four-factor structure of the FCI initially established by White and colleagues (2002). In addition, we sought to assess whether the three-factor structure of the DEBQ could be replicated in pregnant respondents (Van Strien et al., 1986). Women with overweight and obesity prior to pregnancy are more at risk for excess gestational weight gain and thus may be uniquely affected by food cravings and emotional, external, and restrained eating in pregnancy. Therefore, we also examined the fit of both measures in the subsample of women who reported a pre-pregnancy BMI in the overweight or obese range.

**Methods**

**Participants and Procedures**

Participants were pregnant women either receiving routine prenatal care at the Department of Obstetrics, Gynecology, and Reproductive Sciences at a local academic medical center or recruited online through pregnancy-related websites, forums, and groups.

**Measures**

**Demographics.** Though the content of the questionnaire administered differed somewhat depending on where participants were recruited, all women included in the present analyses \( n = \)
195) provided basic demographics and information about their pregnancy. Demographic questions included age, race/ethnicity, height, current weight, and weight prior to pregnancy. Women indicated their current trimester, weeks’ gestation, and whether they were having a singleton or multiple pregnancy.

**Food Craving Inventory (FCI; White et al., 2002).** The FCI is a 28-item self-report questionnaire that measures specific food cravings. The FCI assesses the “frequency” with which respondents experienced cravings over the last month (Cronbach’s α = 0.89 in the present sample), and the frequency with which they “gave in” to specific cravings over the last month (Cronbach’s α = 0.92). Ratings range from one = “never” to five = “always, almost every day.” The FCI loads onto four factors, both for “frequency” and “giving in.” The four factors include “high fat foods” (Cronbach’s α = 0.76 for “frequency,” 0.79 for “giving in” in the present sample), “sweets” (Cronbach’s α = 0.85, 0.84), “carbohydrates/starches” (Cronbach’s α = 0.77, 0.82), and “fast food fats” (Cronbach’s α = 0.66, 0.78). The FCI has previously been shown to have good test-retest reliability and was shown to be valid in obese and non-obese populations (Martin, O’Neil, Tollefson, Greenway, & White, 2008; White et al., 2002; White & Grilo, 2005).

**Dutch Eating Behaviors Questionnaire (DEBQ; Van Strien et al., 1986).** The DEBQ is a 33-item self-report measure (Cronbach’s α = 0.93). The item is scored on a five-point Likert scale ranging from “never” to “very often.” The scale contains 10 items related to “restrained” eating, for example, “Do you try and eat less at mealtimes than you would like to eat,” (Cronbach’s α = 0.91). The “emotional” eating subscale contains 13 items, including “Do you have a desire to eat when you are bored or restless?” (Cronbach’s α = 0.96). The third subscale, quantifying “external” eating, is comprised of 10 items addressing eating in response to external cues, with items such as, “If you see others eating, do you also have the desire to eat?”
(Cronbach’s $\alpha = 0.86$). The DEBQ was previously validated successfully in individuals with varying BMIs, ethnicities, and ages (Bozan, Bas, & Asci, 2011; Gorman & Allison, 1995; Halvarsson & Sjödén, 1998; Wardle, 1987).

**Statistical Analysis**

A total of 195 pregnant women completed at least one of the measures being evaluated in the current study. Non-significant Little’s Missing Completely at Random tests ($\chi^2 = 366.12, p = 0.43$) indicated that cases in the DEBQ and in the “giving in” scale of the FCI ($\chi^2 = 315.75, p = 0.95$) were missing completely at random. Missing values analysis of the FCI “frequency” scale resulted in a significant Little’s MCAR ($\chi^2 = 578.58, p < 0.01$). Missing values were replaced using Expectation-Maximization imputation (25 iterations).

Previous literature has suggested a sample size of at least five cases per parameter or at least 300 respondents in order to attain adequate power in confirmatory factor analysis (Kline, 2011). Based on this recommendation, sufficient sample size for replication of the FCI was calculated at 320, given the 62 parameters. Replication of the DEBQ includes 69 parameters, resulting in a recommended sample of 345 respondents.

The FCI “frequency” and “giving in” ratings from the 195 participants who completed all items of the scale were subjected to confirmatory factor analyses in SPSS AMOS v. 25 to assess the extent to which the proposed measure fits the original four-factor structure, which includes “high fat foods,” “sweets,” “carbohydrates/starches,” and “fast food fats.” We evaluated the assumptions of multivariate normality and linearity. Assumptions of multivariate normality were violated for “frequency” (Mardia’s coefficient = 124.14, c.r. = 21.15) and “giving in” subscales (Mardia’s coefficient = 203.36, c.r. = 34.64). Individual items did not appear to be skewed;
however, a few individual items had elevated kurtosis values. Bootstrapping of estimates ($n = 500$) was employed to evaluate potential bias.

Univariate outliers were identified in the FCI “frequency” (11 total, range 3.36 – 4.26) and “giving in” (30 total, range 3.31 – 5.22) scales. Mahalanobis distance revealed seven multivariate outliers (MD values ranged from 57.19 to 75.78, $\chi^2 \geq 56.89$) for the subjective report of cravings and 14 multivariate outliers for the behavioral report of cravings (MD values ranged from 57.04 to 77.28, $\chi^2 \geq 56.89$). Analyses were first conducted with the outliers included to maximize statistical power given the small sample size and their plausibility in the sample. Multivariate outliers were subsequently removed to examine if fit in CFA improves. Based on information gathered in a pilot study from 2012$^4$, we included 15 supplemental items (rated on the same scale as the original FCI items) with the hope of capturing some of the additional commonly craved foods, beverages, and non-food substances (i.e., marijuana, alcohol, tobacco, chalk, clay, paint, etc.) endorsed by pregnant women. Frequency of craving for these additional, non-FCI items was examined in post-hoc tests.

From the sample of pregnant women either receiving routine prenatal care at a local academic medical center or those recruited online through pregnancy-related websites, forums, and groups, 186 respondents provided complete data for the DEBQ and were therefore included in the confirmatory factor analysis of this measure. The analysis aimed to assess fit of the data with the original three-factor structure, which consists of “emotional,” “external” and “restrained” eating. The assumptions of normality were assessed in SPSS AMOS v. 25.

$^4$ Preliminary data was collected by surveying online blog posts and message boards that included topics related to craving in pregnancy. The word “craving” was searched on community forums and the first 20 threads were examined. The result was a sample of 200 posts. Responses were categorized according to specific categories (i.e., fast food, prepared dishes, pre-packaged foods), flavor profiles (i.e., sour, sweet, salty, spicy), and types of foods (i.e., vegetables, fruits, sweets).
Univariate skewness and kurtosis were within normal limits, however, multivariate skewness and kurtosis were identified (Mardia’s coefficient = 113.76, c.r. = 16.14). Therefore, bootstrapping (n = 500) was employed to evaluate bias. Items were standardized to identify the presence of univariate outliers. A total of 11 univariate outliers were identified based on the absolute z score being greater than 3.29 (values ranged from 3.40 to 5.23). Multivariate outliers (five total) were indicated if Mahalanobis Distance was greater than $\chi^2 = 63.87$ (MD ranged from 68.46 to 86.15). Again, analyses were first conducted with the outliers to maximize statistical power and then again without the outliers to examine whether there was significant improvement in the model fit.

**Results**

**Descriptive Statistics**

The majority of the combined sample identified as White (70.6%, n = 137). Women who identified as Black/African American made up 11.3% (n = 22), 8.8% were Asian (n = 17), 3.6% were Hispanic/Latino (n = 7), and the remaining 5.7% identified as “other” (n = 11). The sample had a mean age of 30.50 years (SD = 4.80). Nearly half of the sample reported being in their second trimester (47.7%, n = 92; third trimester 36.3%, n = 70; first trimester 16.1%, n = 31). Based on self-reported weight prior to the onset of pregnancy, the average BMI was 27.42 kg/m$^2$ (SD = 4.80). About half the sample (51.6%, n = 96) had a pre-pregnancy BMI in the normal (47.3%, n = 88) or underweight (4.3%, n = 8) range. The remaining 48.4% (n = 90) reported a pre-pregnancy BMI in the overweight (24.2%, n = 45) or obese range (24.2%, n = 45).

**Food Craving Inventory**
A four-factor hypothesized model for the subjective and behavioral scale of the FCI is presented in Figure 1. The four-factor model consists of “high fat foods” (eight items), “sweets” (eight items), “carbohydrates/starches” (eight items), and “fast food fats” (four items).

“Frequency.” Model fit was assessed by examination of the various CFA fit indices. In examining the fit indices, chi-square ratio was less than three (CMIN/df = 1.80) and the root mean square error of approximation was at the cutoff specified by Hu & Bentler (1999) as indicating good model fit (RMSEA = 0.06, 95% C.I. = 0.06 – 0.07) \(^5\). However, the Bollen-Stine bootstrap was significant (\(p = 0.002\)) and several fit indices were outside the acceptable range (CFI = 0.83; AGFI = 0.78; NFI = 0.69). Examination of standardized factor loadings did not indicate that model re-specification was required (Table 3).

“Giving in.” The Bollen-Stine bootstrap was significant (\(p = 0.002\)) and most fit indices were outside the acceptable ranges (CFI = 0.71; AGFI = 0.75; NFI = 0.70), indicating a poor fit of the data and poor replication of the factor structure in the behavioral report of craving. The root mean square error of approximation was in the adequate range for model fit (RMSEA = 0.08, 95% C.I. = 0.07 – 0.09). All paths were significant and thus re-specification of the model was not indicated (Table 4).

The fit of the FCI “frequency” and “giving in” data was analyzed in CFA without the multivariate outliers. Bollen-Stine bootstrap remained significant for “frequency” (\(p = 0.004\)) and for “giving in” (\(p = 0.002\)). For frequency there was no change in the other fit indices (RMSEA = 0.06, 95% C.I. = 0.06 – 0.07; CFI = 0.83; AGFI = 0.78; NFI = 0.69). Removal of the 14 multivariate outliers from the “giving in” scale resulted in a slight improvement in some of

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\(^5\) Fit Indices used include Chi-square ratio (CMIN/df), Bollen-Stine bootstrap, the root mean square error of approximation (RMSEA), comparative fit index (CFI), adjusted goodness of fit index (AGFI), and normal fit index (NFI).
the fit indices, such that root mean square error approximation was closer to the cutoff for “good” fit (0.06) (RMSEA = 0.07, 95% C.I. = 0.07 - 0.08), and slight increases in the normal (NFI = 0.72) and comparative fit (CFI = 0.78) indices. There was no change in the adjusted goodness of fit index (AGFI = 0.75).

**Confirmatory factor analysis in women with a pre-pregnancy BMI in the overweight and obese range.** For the subjective report of cravings, model fit of the four-factor structure was examined in the sample of respondents who reported a BMI in the overweight or obese range prior to pregnancy. Root mean square error of approximation was at the cutoff for adequate fit (RMSEA = 0.08, 95% C.I. = 0.07 – 0.09), Bollen-Stine bootstrap was not significant ($p > 0.05$), and the chi-square ratio was less than three ($\text{CMIN/df} = 1.58$). However, other indices suggested a less than acceptable fit (CFI = 0.81; AGFI = 0.67; NFI = 0.50).

Although the Bollen-Stine bootstrap was not significant ($p = 0.17$), the four-factor structure was not sustained in the behavioral report of craving based on the various fit indices examined (RMSEA = 0.10, 95% C.I. = 0.09 – 0.11; CFI = 0.71; AGFI = 0.63; NFI = 0.54). Examination of the regression weights showed three paths for the frequency scale (FCI item 7, “hot dog”, FCI item 16 “ice cream,” and FCI item 23 “pasta”) that were not significant. When these paths were removed from the model, the Bollen-Stine bootstrap remained non-significant ($p = 0.15$), and the majority of the fit indices either remained the same or improved only slightly (RMSEA = 0.10, 95% C.I. = 0.09 – 0.11; CFI = 0.74; AGFI = 0.64; NFI = 0.58), though they were still not in the acceptable range.

**Other pregnancy cravings.** Due to the lack of fit of the FCI craving data in the current sample, we conducted post-hoc analyses using data collected in the 2012 pilot study to determine the most craved items. Of the original FCI items, women reported the highest frequency of
craving for “chocolate” ($M = 2.90, SD = 1.26$), “ice cream” ($M = 2.80, SD = 1.17$), and “pizza” ($M = 2.78, SD = 1.24$). However, when looking at frequencies of craving for the additional, non-FCI items assessed, including the supplemental foods and beverages, women reported even more frequent cravings for “fruits” ($M = 3.73, SD = 1.26$), and “vegetables” ($M = 3.13, SD = 1.35$), both of which are not items or categories in the original FCI. Furthermore, we found that women craved “fruits” significantly more than the most craved item (“chocolate”) on the FCI, ($t(192) = -8.19, p < 0.01, d = 0.66$). Women also reported more frequent consumption in response to cravings for these supplemental items, “fruits” ($M = 3.95, SD = 1.28$) and “vegetables” ($M = 3.45, SD = 1.51$), compared to the highly rated original FCI items, “chocolate” ($M = 2.79, SD = 1.29$), “pizza” ($M = 2.78, SD = 1.24$), and “cereal” ($M = 2.74, SD = 1.48$). Again, the difference between “giving in” to “fruit” as compared to “chocolate” was significant ($t(188) = -9.90, p < 0.01, d = 0.90$).

**Dutch Eating Behaviors Questionnaire**

The established three-factor model for the DEBQ is presented in Figure 2. The three-factor model consist of “emotional eating” (13 items), “external eating” (10 items), and “restrained eating” (10 items). The confirmatory factor analysis produced somewhat mixed findings with regard to model fit, with a chi-square ratio less than three (CMIN/df = 2.26), however the Bollen-Stine bootstrap was significant ($p = 0.002$). Again, several fit indices were outside the acceptable range (CFI = 0.86; AGFI = 0.67; NFI = 0.77). Based on Hu & Bentler (1999), the root mean square error of approximation was at the cutoff for the “adequate” range (RMSEA = 0.08, 95% C.I. = 0.08 - 0.09). All but one path were significant (DEBQ item 21 “Can you resist eating delicious foods?”). Once this path was removed and the model was reexamined,
it still showed a poor fit to the data (RMSEA = 0.08, 95% C.I. = 0.76 - 0.90; CFI = 0.87; AGFI = 0.68; NFI = 0.79; Bollen-Stine p = 0.002).\(^6\)

**Confirmatory factor analysis in women with a pre-pregnancy BMI in the overweight and obese range.** The model estimation in those that reported a pre-pregnancy BMI greater than 25.00 kg/m\(^2\) was not significant (Bollen-Stine p = 0.16), with a chi-square ratio less than three (CMIN/df = 1.72), indicating good fit. However, all other indices suggest that fit of the data with the original three-factor structure of the DEBQ in this population was less than adequate (RMSEA = 0.09, 95% C.I. = 0.08 – 0.10; CFI = 0.84; AGFI = 0.60; NFI = 0.68). Similar to the model re-specification in the full sample, removal of path 21 did not have an effect on a majority of the fit indices (Bollen-Stine remained significant, p = 0.12; RMSEA = 0.09, 95% C.I. = 0.08 – 0.10; CFI = 0.84; AGFI = 0.60), except for a slight increase in the normative fit index (NFI = 0.70).

**Discussion**

The current study aimed to validate two key measures in testing the predictions of EI Theory of craving etiology in a pregnant sample. The first was an inventory of food craving that was originally validated in a sample of individuals drawn from university and community sources. In its original development the measurement of specific food cravings differed across factors in obese and non-obese individuals, with obese individuals scoring significantly higher on the “high fat foods” factor as compared to normal weight individuals, however there was no difference in total scores (White et al., 2002, White & Grilo, 2005). We attempted to test fit of FCI data with the original four-factor structure (“high fat foods,” “sweets,” “carbohydrates/starches,” and “fast food fats”) in a sample of expecting women and a subsample

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\(^6\) Similar to the FCI, model fit was examined without the multivariate outliers; however, there was no change in Bollen-Stine’s p or the fit indices.
of expecting women with a pre-pregnancy BMI in the overweight or obese range. Neither data on subjective or behavioral aspects of craving fit the four-factor structure. Only in the subsample of overweight/obese women did non-significant paths emerge. However, even with removal of these paths, the fit indices suggested inadequate fit.

It was hypothesized that The Dutch Eating Behavior Questionnaire would be an appropriate fit for this population given that it was developed in response to the lack of eating measures that could transcend different populations and its fit with our conceptualization of craving within the EI framework. Studies have shown that self-report scores on the DEBQ do predict eating, specifically intake of high-fat sweet foods (Domoff, Meers, Koball, & Musher-Eizenman, 2013). This is particularly relevant for our sample given that sweets and calorically dense foods are the most commonly craved and consumed. The DEBQ has been used to assess eating behavior in samples of individuals with overweight and obesity (Burton et al., 2007, Gossens et al., 2009; Larsen et al., 2006), and thus we also looked at the factor structure in the sample of women who reported overweight or obesity prior to pregnancy. Neither data from the full sample nor the sample of overweight/obese women fit the original three-factor structure well. In both samples, one path was non-significant, which was removed, however, there was no change in the fit indices.

The current findings should be interpreted cautiously given that the sample size did not meet the minimum requirements for adequate power in CFA. Future studies should aim to replicate the factor structure in a larger sample of expecting women. Other recommendations include validation of the other well-known restraint scales, such as the Revised Restraint Scale (RRS; Polivy, Herman, & Howard, 1988) or the Eating Inventory/Three Factor Eating Questionnaire (EI; Stunkard & Messick, 1985). Notably, the RRS was modified for pregnancy
and was previously found to be associated with gestational weight gain (Conway et al., 1999; Mumford et al., 2008), however this finding was not upheld in a more recent study (Heery, Wall, Kelleher, & McAuliffe, 2016). It is posited that the RRS does not have the ability to parse out restrained eating from disinhibited eating. Therefore, continued validation of these scales is warranted in order to inform future research looking at the associations between eating styles, craving, and excess gestational weight gain.

Limitations

One explanation for the present lack of fit in the CFA is sample size. Based on Kline’s (2011) recommendation and the number of parameters in each scale, the FCI and the DEBQ require at least 300 respondents for adequate power. However, it should be noted that for the FCI, confirmation of the four-factor structure has previously been conducted in comparable samples of obese individuals (n = 122) (White & Grilo, 2005). The DEBQ has also been validated in normal weight and obese respondents (Wardle, 1987), as well in a sample of children (Halvarsson & Sjödén, 1998), all with a sample sizes of less than 300. Thus, further investigation (i.e., validation in a larger sample) is required to confidently determine that it is a lack of power influencing the fit, rather than these scales being inappropriate for quantifying food cravings in pregnant women.

Beyond sample size, it is important to note that the FCI may not capture all cravings endorsed by pregnant women. We identified a number of substances and non-food substances that expecting women crave in an earlier pilot study that are not included on the FCI. These items differed from the original 28 items in type of craving, flavor profile, category, and the inclusion of non-substance foods. Our post-hoc analyses showed that two of the supplemental items (i.e., fruit and vegetables) were craved significantly more frequently than any of the
original items in the measure. In addition, our sample reported giving in to these foods more often than items from the FCI. Future studies should consider developing a modified version of the inventory that includes items such as those identified in our pilot study, for pregnant women.

Conclusion and Future Directions

For some, pregnancy can be a reprieve from weight and shape concerns, though for others prior disordered eating behaviors can increase the vulnerability to overeating (Abraham et al., 1994; Fairburn & Welch, 1990; Soares et al., 2009) and excess gestational weight gain (Conway et al., 1999; Mumford et al., 2008). We hypothesized that this vulnerability can be conceptualized within the framework of EI Theory of desires, such that these pre-pregnancy beliefs are related to how women attend to and elaborate on food-related thoughts throughout pregnancy. However, research requires adequate scales in order to explore these associations and furthermore, develop appropriate interventions. The findings from the current study provide a rationale for further data collection in this population in order to validate eating measures and begin to explore the exact nature of the relationship between eating behaviors and gestational weight gain.
Study 2:
Food Cravings in Pregnancy Predict Excess Gestational Weight Gain

Introduction

An estimated 50 – 90% of women in the United States experience food cravings during pregnancy (Bayley et al., 2002, Fairburn, Stein, & Jones, 1992; Flaxman & Sherman, 2000; Hook, 1978; Pope et al., 1992; Tierson et al., 1985; Worthington-Roberts, Little, Lambert, & Wu, 1989). The lack of rigorous research designed to identify the causes and consequences of these cravings (Orloff & Hormes, 2014) is alarming given that evidence points to food cravings as a trigger of binge eating episodes, predictor of weight gain, and major barrier to sustained weight loss in the general population (Bjoervell et al., 1985; Greeno, Wing, & Shiffman, 2000; Massey & Hill, 2012). As an answer to the call from the Institute of Medicine for work designed to identify psychosocial risk factors of excess gestational weight gain (Rasmussen & Yaktine, 2009), the current study aims to explore whether cravings influence risk of overweight and obesity specifically in pregnancy. Previous literature has indicated that cravings play a role in excess gestational weight gain; however, the research is cross-sectional (Orloff et al., 2016) and qualitative (Anderson et al., 2015). There remains a need for research tracking cravings longitudinally to determine with more certainty their causal effect on weight gain across gestation.

Study Aim

The current study aimed to quantify the impact of specific food cravings during pregnancy on excess gestational weight gain prior to delivery. Findings have potentially important implications for identification of targets for the treatment and prevention of overweight and obesity in pregnancy.
Methods

Procedures and Participants

Participants \((n = 84)\) were pregnant women receiving routine prenatal care at the Department of Obstetrics, Gynecology, and Reproductive Sciences at a local academic medical center. Women were invited to complete up to three questionnaires during pregnancy (corresponding to the three trimesters of gestation) and an additional questionnaire during the post-partum. Women who completed at least one questionnaire during pregnancy and gave consent for review of their medical records were included in the study, resulting in a final sample of 45 respondents, which are included in the following analyses.

Measures

Demographics. The first questionnaire completed gathered a large amount of demographic information, including race/ethnicity, age, sex, weight history, pregnancy history, and socioeconomic status. Information pulled from the medical records included weight at the final OBGYN visit prior to delivery as well as weeks of gestation at that visit.

Participants provided their height and retrospective reports of their pre-pregnancy weight. This information was used to calculate BMI prior to pregnancy and to determine pre-pregnancy weight class (i.e., underweight, normal weight, overweight, and obese). Participants’ final weights taken at their physicians’ office prior to delivery were used to calculate excess gestational weight gain based on formal recommendations for appropriate weight gain in pregnancy for each participants’ weight class (Table 6).

Food Craving Inventory (FCI) (White et al., 2002). See detailed description in Study 1 (pp. 25). In the current sample, the measure was found to have good reliability for both scales, measuring “frequency” of specific food cravings (total: Cronbach’s \(\alpha = 0.88\); factors: “high fat
foods” Cronbach’s α = 0.79; “sweets” Cronbach’s α = 0.85; “carbohydrates/starches” Cronbach’s α = 0.72; and “fast food fats” Cronbach’s α = 0.46) and the likelihood of “giving in” to those cravings (total: Cronbach’s α = 0.89; factors: “high fat foods” Cronbach’s α = 0.77; “sweets” Cronbach’s α = 0.80; “carbohydrates/starches” Cronbach’s α = 0.81; and “fast food fats” Cronbach’s α = 0.73). It is of note that the replication of this factor structure in our sample of pregnant women did not yield adequate fit so findings should be interpreted with some caution (See Study 1).

**Food Cravings Questionnaire- Trait (FCQ-T; Cepeda-Benito et al., 2000).** The FCQ-T is a 39-item self-report measure used to assess stable behavioral, cognitive, and physiological features of general food cravings (Cronbach’s α = 0.97). Ratings range from one = “never” to six = “always” and load onto nine factors quantifying “intention” (Cronbach’s α = 0.80), “positive reinforcement” (Cronbach’s α = 0.87), “relief” (Cronbach’s α = 0.85), “lack of control” (Cronbach’s α = 0.91), “preoccupation” (Cronbach’s α = 0.91), “physiological” (Cronbach’s α = 0.82), “emotions” (Cronbach’s α = 0.82), “environmental cues” (Cronbach’s α = 0.82), and “guilt” (Cronbach’s α = 0.82). The FCQ-T has good test-retest reliability and validity (Moreno, Rodriguez, Fernandez, Tamez, & Cepeda-Benito, 2008).

**Statistical Analysis**

The majority of respondents (95.6%, n = 43) reported having a singleton pregnancy. One respondent who delivered multiples and one respondent who experienced a miscarriage after completion of the initial questionnaire were excluded from the final analyses. We calculated excess gestational weight gain based on the recommended guidelines released by the IOM (Rasmussen & Yaktine, 2009) and participant’s pre-pregnancy BMI category. Recommended weight gain was subtracted from actual weight gain to calculate an index of “excess gestational
weight gain” prior to delivery. For the primary analyses, variables of interest were normally distributed and homoscedastic with no multi-collinearity as indicated by VIF values below 10.00. Associations between food cravings and excess gestational weight gain were examined using Pearson’s product correlation coefficients and multiple regression analyses. An a priori power analysis suggested a required sample size of \( n = 45 \) for adequate power (.80) to detect medium/large-sized effects \( (f^2 = .30) \) in multiple linear regression analysis with four predictors and \( \alpha = 0.05 \).

**Results**

**Descriptive Statistics**

The majority of respondents identified as White (58.1%, \( n = 25 \)) and one quarter identified as Black/African American (25.6%, \( n = 11 \)). There was less representation of Hispanic/Latino (14.0%, \( n = 6 \)) and Asian (9.3%, \( n = 4 \)) women in the sample. Over half of the sample reported being married (58.1%, \( n = 25 \)), 20.9% (\( n = 9 \)) were single, 16.3% (\( n = 7 \)) cohabitating, 4.7% (\( n = 2 \)) in a relationship, but living alone, and 2.3% (\( n = 1 \)) were separated or divorced at the time of the first survey completion. Household incomes varied, with half of the sample (48.8%, \( n = 20 \)) reporting a yearly income below $70,000 and half the sample (51.2%, \( n = 21 \)) reporting incomes above $70,000. Notably, when asked individual annual incomes, more than half of the sample (51.3%, \( n = 20 \)) reported individual incomes less than $30,000.

Participants’ ages ranged from 18 to 40 years (\( M = 30.77, SD = 5.13 \)).

Half of the respondents were in their second trimester (51.2%, \( n = 2 \)) and a little over 21 weeks’ gestation (\( M = 21.14, SD = 3.40 \)) when they completed their first time-point questionnaire. Of the remaining participants, 32.6% reported being in their third trimester (\( n = 14 \); weeks’ gestation: \( M = 32.75, SD = 3.24 \)) and 16.3% were in their first trimester at the time of
first survey completion \((n = 7; \text{weeks’ gestation: } M = 10.14, SD = 1.35)\). Average pre-pregnancy BMI was 30.15 kg/m\(^2\) \((SD = 11.80)\). Over one third of the sample \((41.9\%, n = 18)\) had a body mass greater than 30 kg/m\(^2\) prior to becoming pregnant, putting them in the obese range. Body masses in the normal range \((18.5 – 24.9 \text{ kg/m}^2)\) were reported by 34.9\% \((n = 15)\), 18.6\% \((n = 8)\) had a BMI in the overweight range \((25.0 – 29.9 \text{ kg/m}^2)\), and the remaining 4.7\% \((n = 2)\) reported a BMI under 18.5 kg/m\(^2\) prior to pregnancy, putting them in the underweight range. At the participants’ final office visit before delivery, 39.5\% \((n = 17)\) had gained more than five pounds in excess of what was recommended based on their pre-pregnancy weight class, 27.9\% \((n = 12)\) gained within five pounds, above or below, of recommended, and 32.6\% \((n = 14)\) had weight gain that fell more than five pounds below recommendations.

The most commonly endorsed cravings were for “sweets” and “fast foods,” with women reporting somewhat less frequent cravings for “carbohydrates/starches” and “high fat foods.” (Table 7). Similarly, women reported giving in to cravings for “sweets” and “fast foods” more frequently than giving in to cravings for “carbohydrates/starches” and “high fat foods.” Looking at ratings of frequency of craving for specific foods, women reported the most frequent cravings for chocolate \((M = 2.90, SD = 1.30)\), ice cream \((M = 2.80, SD = 1.12)\), and pizza \((M = 2.78, SD = 1.12)\). Similarly, women reported most frequently giving into their cravings for pizza \((M = 3.02, SD = 1.24)\), ice cream \((M = 3.00, SD = 1.26)\), and chocolate \((M = 2.95, SD = 1.24)\).

**Association between Food Craving and Excess Gestational Weight Gain**

Multiple regression analyses indicated that craving frequency accounted for 46.7\% of the variance in excess gestational weight gain \((F(4, 24) = 5.26, p < 0.01, R^2 = 0.47)\). Frequency of cravings for “high fat foods” \((p < 0.01)\), “carbohydrates/starches” \((p = 0.03)\), and “fast foods” \((p = 0.03)\) emerged as significant predictors of excess gestational weight gain (Table 7). In contrast,
behavioral report of cravings (i.e., “giving in”) did not account for a significant amount of the variance in excess gestational weight gain ($F(4, 29) = 0.49, p = 0.74, R^2 = 0.06$).

In the third full regression model, FCQ-T scores of craving related to one’s “physiological” state and “intention and plans to consume food” emerged as significant predictors of amount of excess weight gain prior to delivery ($p = 0.03$ and 0.04, respectively). Overall, the regression model was significant ($F(9, 27) = 2.78, p = 0.02, R^2 = 0.48$), with combined FCQ-T subscale scores accounting for 48.1% of the variance in excess weight gain (Table 8).

**Regression in women with a pre-pregnancy BMI in the overweight or obese range.**

Based on the literature showing a unique vulnerability for excess gestational weight gain in women with a pre-pregnancy BMI in the overweight or obese range, the effect of craving, as measured by the FCI and the FCQ-T, on gestational weight gain was examined in the subset of women reporting BMI $> 25 \text{ kg/m}^2$ ($n = 21$). The data was examined prior to running the regression analyses, which showed that the FCQ-T was non-normally distributed and outliers were present. Log transformations were applied prior to the analyses, which resulted in skewness statistics in the acceptable range.

“Frequency” of cravings, as measured by the FCI, accounted for 49.9% of the variance in excess weight gain in the overweight/obese sample, however the full regression model was not significant ($F(4, 12) = 2.99, p = 0.06, R^2 = 0.50$) (Table 9). Frequency of “giving in” to cravings also did not account for a significant portion of the variance in weight gain ($F(4, 13) = 0.02, p = 0.99, R^2 = 0.01$).

In the regression of the FCQ-T, three factors, “intentions,” “physiological,” and “environmental cues,” emerged as significant predictors of weight gain for women with a pre-
pregnancy BMI in the overweight or obese range (all \( p \)'s \( \leq 0.01 \)). The full regression was significant \((F(9, 12) = .02, p = 0.01, R^2 = 0.75)\), with the FCQ-T accounting for 75.1% of the variance in excess gestational weight gain (Table 10).

**Discussion**

To the best of our knowledge, this is the first longitudinal study to examine the hypothesized causal role of food cravings in pregnancy in excess gestational weight gain. Our findings suggest that certain stable aspects of general food craving and the frequency of specific food cravings account for a substantial portion of the variance in excess gestational weight gain, and this holds true for women with pre-pregnancy overweight and obesity. Results are consistent with preliminary data from an earlier cross-sectional study showing that food cravings are associated with excess weight gain in pregnancy (Orloff et al., 2016).

Qualitative research has demonstrated that difficulties coping with food craving is a primary barrier to healthy gestational weight gain specifically in low-income, overweight/obese (Anderson et al., 2015), and African American women (Goodrich, Cregger, Wilcox, & Liu, 2013). In a study conducted by Goodrich and colleagues (2013), one woman (African American, obese) recalled her experience battling food cravings, stating “’cause when you crave stuff, it’s like I’ve got to have that taste…sometimes I slip and go get the bag of chips and the stuff and eat them ‘cause I’m craving it.” It is hypothesized that expecting mothers lack the skills necessary to cope effectively with cravings, resulting in greater risk of overconsumption, in particular of highly processed and/ or calorically dense foods.

Specific foods, such as high fat and calorically dense items, as well as underlying traits, including intentions, physiological state, and environmental cues emerged as specific predictors of weight gain. These are consistent with the published literature, with earlier studies
highlighting the relevance of these traits in the development and maintenance of craving (Weingarten & Elston, 1990). Our proposed model of craving etiology conceptualizes craving as a product of the interaction of physiology, environmental cues, and cognitive motivation. Women are living in an “obesogenic” environment, constantly confronted with highly palpable and calorically dense foods that are considered “taboo” (Anderson et al., 2015; Goodrich et al., 2013; Snow & Johnson, 1978). These environmental cues are likely interacting with other physiological and emotional factors, which in turn trigger the craving. In line with the EI framework (Kavanagh et al., 2005), the craving is expanded on by elaboration of thoughts associated with eating in pregnancy such as the notion of “eating for two” (Copleton, 2007). This elaboration leads to an intensification of the craving episode.

A meta-analysis of interventions for maternal weight gain found that a substantial amount of research has focused on women who are obese and/ or overweight (Thangaratinam et al., 2012). One focus of this research has been on controlling gestational diabetes to mitigate related complications in delivery and adverse effects on maternal and fetal health (Landon et al., 2009; Ney, Hollingsworth, & Cousins, 1982; Rae et al., 2000). These interventions typically promote lifestyle changes by increasing physical exercise (Santos et al., 2005) or changing dietary habits (Guelinckx, Devlieger, Mullie, & Vansant, 2010; Thorton, Kopacz, & Ishoof, 2009; Wolff, Legarth, Vangsgaard, Toubro, & Astrup, 2008). Guelinckx and colleagues (2010) found significant changes in dietary habits across the course of pregnancy in their passive and active groups as compared to their control group. While the first two groups increased their protein and vegetable intake and had a decrease in their fat intake, the control group showed an opposite

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7 Women in the passive condition received a brochure with advice on nutrition and physical activity, women in the active group received the brochure as well as counseling by a nutritionist and attended three group nutrition sessions, and women in the control group received routine prenatal care (Guelinckx et al., 2010)
trend, where they significantly increased their energy intake from fat and decreased their protein intake. Interestingly, these dietary changes did not have a significant effect on gestational weight gain or physical activity (Guelinckx et al., 2010). These results are consistent with what other researchers have found, which is a lack of success of interventions targeting weight and weight-related health in obese, nondiabetic pregnant women (Asbee et al., 2009; Jeffries, Shub, Walker, Hiscock, & Permezel, 2009; Phelan et al., 2011; Vinter, Jensen, Ovesen, Beck-Nielsen, & Jorgensen, 2011). Notably, some of these interventions do appear to be effective in women who are of normal weight prior to the onset of pregnancy (Asbee et al, 2009; Phelan et al., 2011). Future research should focus on the development and implementation of interventions that target cravings in all women, especially those that have high BMI prior to the onset of pregnancy.

**Limitations**

There are several notable limitations in the current study. We employed a longitudinal design; however, the measure used to assess food cravings asked women to report on their cravings over the last month. The subjective and fleeting nature of cravings suggests that retrospective reporting of frequency is adequate, at best (Nordin et al., 2004). While the measures used in this study are empirically validated (Cepeda-Benito et al., 2000; White et al., 2002), we were unable to replicate the factor structure of the FCI in our sample of expecting women (See Study 1). Moreover, research has demonstrated that using ecological momentary assessment (EMA) is a more accurate way to capture food craving frequency and consumption (Carels et al., 2001; Grenard et al., 2013; Mason, Jhaveri, Cohn, & Brewer, 2018). Future studies should incorporate EMA technology and more appropriate self-report measures to assess the frequency, type, and consumption of food cravings throughout the course of pregnancy.
Consistent with prior cross-sectional work, there was a difference in participants’ subjective report ("frequency") of craving versus their behavioral ("giving in") report. In previous research, there has been significant overlap in the subjective and behavioral report of craving; however, that does not seem to be the case in the current sample (White et al., 2002). We have identified two different explanations that can account for the difference in significance between “frequency” and “giving in.” The first is fatigue. The formatting of our questionnaires had participants fill out the inventory first for “frequency” of cravings for 28 specific foods in the last month, second for “frequency” of cravings for the same foods before pregnancy, third for frequency of “giving in” in to cravings for each of the 28 foods in the last month, and finally for frequency of “giving in” before pregnancy. Future research in this population should consider switching up the order in which questionnaires are administered to minimize repetition and burnout.

The second explanation is the differing emotions attached to “frequency” versus “giving in.” Foods that are highly palatable yet perceived as “forbidden” tend to cause conflicting feelings for women. This conflict can increase attention to and elaboration on the craving, ultimately intensifying craving episodes (Cartwright & Stritzke, 2008; Hormes & Rozin, 2011; Kavanagh et al., 2005). In order to reduce the shame around this internal conflict, we hypothesize that women in our sample may be more apt to endorse experiencing the craving, rather than admitting to the behavior associated with the drive.

**Conclusion and Future Directions**

The primary goal of the current study was to build on previous cross-sectional and qualitative studies and demonstrate that food cravings play a significant causal role in excess weight gain, using a longitudinal design. Results from the current study answer the call from the
IOM to identify novel risk factors of excess weight gain during pregnancy. Findings specifically point to the more effective management of cravings as a potentially worthwhile focus of interventions targeting overweight and obesity in pregnancy. Some studies aiming to reduce food cravings rely on low or very-low calorie diets, vegan diets, or a diabetic exchange plan (Barnard et al., 2009; Harvey et al., 1993; Martin, O’Neil, & Pawlow, 2006). However, the nature of these diets may not be appropriate for expecting women. Alternatively, mindfulness interventions are beneficial treatments for cravings for drugs, alcohol, and food (Alberts et al., 2010; Alberts, Thewissen, & Raes, 2012; Bowen et al., 2009; Forman et al., 2007, Hochster, Block-Lerner, Marks, & Erblich, 2018). Such techniques aim to increase awareness of the craving and acceptance of the emotional experience to reduce reactivity (Forman & Butryn, 2015). In the context of EI Theory, mindfulness-based approaches disrupt the elaboration of thoughts associated with the craved target. Mindfulness-based approaches have been shown to be effective for binge eating and reduction of intake in individuals with overweight and obesity, pointing to the potential utility of these interventions in reducing craving frequency and over-consumption during pregnancy (Dalen et al., 2010; Forman et al., 2007, 2013; Godfrey, Gallo, & Afari, 2015).

The adverse consequences of excess weight gain during pregnancy are well studied. What requires further investigation is identification of other key factors that put women at risk for excess weight gain and identification of potential mechanisms driving the relationship between food craving and weight gain. With more clarity around the factors associated with excess weight gain, development of interventions is possible. With the research that is available, a suggested first step is to use this “teachable moment” that women experience to increase awareness of food cravings, followed by skills acquisition to cope with the craving.
Study 3:

Prenatal Health- and Weight-Related Knowledge in Pregnant and Non-pregnant Respondents

Introduction

The Institute of Medicine most recently updated their 1990 guidelines for healthy weight gain during pregnancy in 2009. The 2009 re-examination was deemed necessary given the increasing demographic diversity among American women of childbearing age. At the time the new guidelines were published women were on average heavier (8% had BMIs that fell in the category of extreme obesity (BMI ≥ 40 kg/m²)), more racially and ethnically diverse, older, and more likely to experience co-occurring chronic medical conditions (Ogden et al., 2006).

In an effort to address the increased diversity of women of childbearing age, the 2009 guidelines incorporate pre-pregnancy BMI as a determining factor of suggested weight gain during gestation (Rasmussen & Yaktine, 2009). Women who have a higher pre-pregnancy BMI are encouraged to gain less weight as compared to those that start pregnancy with a BMI classified as normal or underweight (Rasmussen, Catalano, & Yaktine, 2009). Broadly speaking, weight gain decreases by about 10 pounds with each increase in weight class. Thus, women who are underweight (i.e., pre-pregnancy BMI < 18.5 kg/m²) should gain between 28 and 40 pounds during pregnancy. Women with a normal pre-gravid BMI (18.5 kg/m² to 24.99 kg/m²) are expected to gain between 25 and 35 pounds. Weight gain between 15 and 25 pounds is recommended for women who are in the overweight weight class prior to pregnancy (BMI 25 kg/m² to 29.99 kg/m²). Finally, women with a BMI greater than 30 kg/m² pre-pregnancy should gain between 11 and 20 pounds based on the 2009 guidelines (Table 6). Notably, BMI categories have been modified recently, with the “obesity” category now differentiating between obesity I
(BMI 30 kg/m\(^2\) to 34.99 kg/m\(^2\)), obesity II (BMI 35 kg/m\(^2\) to 39.99 kg/m\(^2\)), and extreme obesity/obesity III (BMI $\geq 40$ kg/m\(^2\)), however specific gestational weight gain guidelines have not been established for these three subclasses.

Even before the 2009 revamping of the IOM guidelines for healthy gestational weight gain there was a push for more effective dissemination of correct information regarding appropriate weight gain by health care providers to expecting mothers. As many as 85% of gynecologists and obstetricians surveyed state that they provide information to their patients about appropriate weight gain/control, dieting, and physical activity (Power, Cogswell, & Schulkin, 2006). However, a significant number of women report that they never received information regarding weight gain from their provider, or that the information they received at the beginning of pregnancy was inaccurate (Cogswell, Scanlon, Fein, & Schieve, 1999; Stotland et al., 2005; Tovar, Chasan-Taber, Bermudez, Hyatt, & Must, 2010). In qualitative research, some expecting mothers also state that the information they received did not come from their physician, but rather from their nutritionist or family members (Tovar et al., 2010). In addition, there is evidence showing that recommendations are given selectively based on pre-gravid weight class, with women with pre-pregnancy overweight/obesity typically receiving less information about appropriate weight gain than women who are under- and normal-weight at the start of pregnancy (Tovar et al., 2010). More research is needed to determine if this differential treatment is due to a reluctance to broach the subject of weight with those already affected by overweight and obesity, or to a lack of knowledge on the part of providers about what constitutes appropriate gestational weight gain in those with overweight/obesity.

Consistent with these reports, studies show that fewer than 50% of pregnant women have accurate knowledge of recommendations regarding healthy weight gain during pregnancy.
(Brown & Avery, 2012; Ledoux, Van Den Berg, Leung, & Berens, 2015; McDonald et al., 2011; Shub, Huing, Campbell, & McCarthy, 2013). These findings are also supported by data showing that between 2012 and 2013, only 32.1% of pregnant women in the United States gained an appropriate amount of weight, whereas 20.4% gained an inadequate amount of weight and 47.5% gained excessive weight during pregnancy (Deputy, Sharma, & Kim, 2015). The high prevalence of inadequate weight gain can be explained by a desire to maintain one’s pre-pregnancy weight class or even lose weight during pregnancy (Bish, Chu, Shapiro-Mendoza, Sharma, & Blanch, 2003). The risk of excess weight gain is greater for those that are heavier prior to the onset of pregnancy. Deputy and colleagues (2015) found that the prevalence of excess gestational weight gain was 23.5% for underweight women, 37.6% for normal weight, 61.6% for overweight, and 55.8% for obese women. Women with pre-pregnancy overweight or obesity experience higher rates of miscarriage (Wang, Davies, & Norman, 2002), gestational diabetes (Callaway, Prins, Change, & McIntyre, 2006; Doherty, Magann, Francis, Morrison, & Newnham, 2006; Rudra, Sorensen, Leisenring, Dashow, & Williams, 2006), hypertension, and pre-eclampsia (Doherty et al., 2006; Leeners et al., 2006; Rode, Nilas, Wojdemann, & Tabor, 2005). Research also supports a positive and significant relationship between pre-pregnancy BMI and caesarean section (Barau et al., 2006; Graves, DeJoy, Heath, & Pekow, 2009). Finally, women who gain excess weight during pregnancy are the most at risk for post-partum weight retention (Gore, Brown, & West, 2003) and both excess gestational weight gain and post-partum weight retention are predictors of long-term obesity (Rooney & Schauberger, 2002).

The evidence that excessive gestational weight gain is pervasive and especially prevalent in women who are already at a higher weight prior to pregnancy is unequivocal. Research on the dissemination of appropriate knowledge regarding weight gain in pregnancy, on the other hand,
remains mixed. There also remains a lack of studies designed to connect level of knowledge regarding appropriate weight gain to actual weight gain during pregnancy. In other words, it is not clear that more accurate knowledge regarding weight gain in gestation is associated with healthier behaviors. In a recent study of the links between health literacy and gestational weight gain, Shulman & Kottke (2016) found that two thirds of women received information about weight gain recommendations, with 80% stating that they received this information from their health care provider. However, 21% of the sample endorsed inaccurate knowledge regarding the appropriate amount of energy to consume in pregnancy, noting that they planned to “eat for two” (i.e., if interpreted literally, this would translate to as much as 4000 calories per day, based on current daily recommendations for energy consumption for women).

Current guidelines suggest that caloric intake increase over the course of pregnancy, such that no additional calories (i.e., above recommended pre-pregnancy daily intake) are recommended during the first trimester, with a recommended increase of 340 calories per day during the second trimester, and an additional 110 calories per day (i.e., 450 total additional calories) during the last trimester (Wolfram, 2017). One study showed that at the time of delivery, 40% of pregnant women surveyed exceeded these recommendations, with only 30% gaining within the IOM guidelines (Shulman & Kottke, 2016). Shulman & Kottke (2016) assessed general knowledge, including asking whether all women should gain the same amount of weight and how women intended on eating during pregnancy (i.e., “eat twice as much,” “eat a little more,” “eat the same amount,” and “eat less”). Pre-pregnancy weight class, correct identification of pre-pregnancy weight class, and accurate weight gain knowledge emerged as significant predictors of appropriate weight gain (Shulman & Kottke, 2016). One hypothesis presented to explain the increasing prevalence of overweight and obesity in pregnancy is the
possibility of a deficit in dissemination of education of weight gain and nutrition during pregnancy.

**Study Aims**

This study was designed to assess expecting women’s knowledge about appropriate weight gain and healthy nutrition during pregnancy. Similar to previous studies, the current study utilized questions to assess knowledge about recommended weight gain and women’s beliefs about appropriate daily caloric intake. However, our study had the added benefit of asking women to indicate, in numeric format, their knowledge of appropriate weight gain and additional caloric intake. Primary aims were to compare expecting women’s knowledge to published guidelines and to a convenience comparison sample to highlight whether women are receiving the correct information, and if this information is above and beyond what is known in the general, non-pregnant population. A secondary aim of the study was to build upon published research (Shulman & Kottke, 2016) to assess health literacy specific to weight gain in pregnant women and to evaluate its association with excess gestational weight gain. An association between incorrect knowledge and weight gain would suggest a need to focus interventions on education. A lack of an association between knowledge and excess gestational weight gain, or excess gains in spite of correct knowledge, would suggest that interventions should target other factors thought to account for the variance in weight gain.

**Methods**

**Participants and Procedures**

The current study drew from two samples of pregnant women, those recruited in the Department of Obstetrics, Gynecology, and Reproductive Sciences at a local medical center and those recruited online through various pregnancy-related forums, messages boards, and
webpages. We also collected data from a convenience sample of undergraduate students to be able to compare knowledge levels in pregnant women to the general population.

**Measures**

**Demographics.** All participants ($n = 894$) completed a series of demographic questions. However, because data was collected using a variety of recruitment methods the amount of demographic data each participant filled out varied. All participants were asked to provide information regarding age, sex, and race/ethnicity. Pregnant women recruited at the local academic medical center provided the most detailed information, including data on prepregnancy weight, income, and educational attainment. Finally, a portion of pregnant women recruited in person provided additional consent for their medical records to be reviewed following delivery, allowing us to conduct a preliminary examination of the association between knowledge and actual weight gain in pregnancy in a small subset of the women surveyed.

**Knowledge questions.** To gather data on knowledge of nutrition and weight gain during pregnancy, participants answered a series of questions developed specifically for this study. To assess knowledge about caloric intake participants were asked to indicate their estimate of how many additional daily calories a woman should consume during pregnancy: “*How many additional calories do you think is the appropriate amount to consume daily during pregnancy?* ("Additional” meaning on top of the calories the woman would have consumed before the pregnancy).” Participants were also asked how much weight gain is recommended during pregnancy, “*How much weight should you gain during a single pregnancy (that is, pregnant with only one baby, not multiples?)*.”

**Statistical Analysis**
The pregnant sample’s estimates (suggested daily caloric intake and suggested weight gain) were compared to published guidelines using a one-sample t-test. Pregnant women and undergraduates’ knowledge of prenatal weight gain and caloric intake were compared in independent samples t-test in order to determine whether there is a discrepancy in knowledge between expecting women and the general population. Additionally, gender differences in knowledge between undergraduate females and males was explored via independent samples t-tests.

Excess gestational weight gain was calculated based on the IOM guidelines (Rasmussen & Yaktine, 2009) and pre-pregnancy BMI (Table 6). Recommended weight gain, based on participants’ self-reported pre-pregnancy BMI, was subtracted from actual weight gain as captured at the participants’ final visit before delivery. Weight at the final visit was extracted from medical records obtained from the academic medical center. Multiple linear regression and Pearson’s product correlation coefficients assessed associations between lack of knowledge of weight gain and caloric intake and excess weight gain. A post-hoc power analysis indicated low power (0.34) for the regression analysis with three predictors and $\alpha = 0.05$.

**Results**

**Descriptive Statistics**

Of the total sample examined here ($n = 894$), 70% were undergraduates ($n = 626$). Just over half of the undergraduate sample was female (50.5%, $n = 314$). The remaining 30% of the total sample was comprised of pregnant women ($n = 268$), 68.6% of which were recruited online ($n = 184$) and the remaining 31.4% ($n = 84$) were recruited among the population of women receiving routine prenatal care at a local academic medical center. The majority of the pregnant (61.2%, $n = 164$) and undergraduate sample (51.3%, $n = 321$) identified as White. The pregnant
sample had an average age of 30.33 years ($SD = 4.93$) and the undergraduate sample had an average age of 18.83 years ($SD = 1.70$).

Of those who provided this information regarding their pregnancy, 97.8% of expecting mothers reported having a singleton pregnancy ($n = 133$); 2.2% were pregnant with multiples ($n = 3$) and were excluded from further analyses due to differences in guidelines regarding weight gain and caloric intake. Self-reported pre-pregnancy weights indicated that 45.6% ($n = 98$) of the pregnant sample had a BMI in the normal range, 24.7% ($n = 53$) were overweight, and 24.2% ($n = 52$) were obese prior to the onset of pregnancy. A small portion of the sample (5.6%, $n = 12$) reported BMIs less than 18.5 kg/m$^2$, indicative of pre-pregnancy underweight. Those identified as underweight were excluded from the analyses examining knowledge of weight gain due to the small sample size and lack of power for comparisons to the remainder of the sample. Excess gestational weight gain was calculated for women who had weight data from their final visit at their physician prior to delivery ($n = 43$). For those who had this information, 39.5% ($n = 17$) gained weight in excess of five pounds of what was recommended, 27.9% ($n = 12$) gained within five pounds of what was recommended, and 32.6% ($n = 14$) had inadequate weight gain (i.e., more than five pounds below what was recommended).

**Comparing Pregnant Women’s Knowledge to Published Guidelines**

**Caloric intake.** A series of one-sample t-test was used to determine if a statistically significant difference exists between reported knowledge of recommended caloric intake, overall and during each trimester, as compared to actual recommended guidelines. Overall, the sample’s report of additional caloric intake was significantly different from recommended$^8$ ($t(156) = 6.98$, $p < .001$).
As stated, daily caloric intake differs by trimester. Women in their first trimester \((n = 24)\) reported estimates of recommended additional caloric intake ranging from 100 to 2300 calories per day \((M = 402.27, SD = 436.84)\). For women in the first trimester, knowledge of caloric intake significantly differed from recommended guidelines, \(t(21) = 4.32, p < 0.001, d = 0.92\). Women in their second trimester \((n = 75)\) reported estimates of additional intake ranging from zero to 3000 calories \((M = 687.07, SD = 749.37)\). A one-sample t-test compared expecting mothers’ estimates to the recommended additional intake of 340 calories in the second trimester, which was significantly different from what is recommended, \(t(74) = 4.011, p < 0.001, d = 0.46\). Recommendations suggest an additional 450 calories per day for women in their third trimester. The current sample of respondents in their third trimester at the time of survey completion \((n = 55)\) reported that they believed an additional intake between 75 and 2700 calories \((M = 782.73, SD = 821.19)\), is sufficient during the last trimester, which was significantly higher than the recommended amount, \(t(54) = 3.01, p = 0.004, d = 0.41\).

**Weight gain.** One-sample t-test identified discrepancies between women’s knowledge of gestational weight gain, based on their pre-pregnancy weight class, and IOM recommendations. Power was a limitation when examining knowledge by weight category, so the full sample’s knowledge was compared to the average recommendation of 30 pounds. Women’s knowledge of weight gain was significantly different from the average of what is recommended, \(t(164) = -2.32, p = 0.02, d = 0.18\). As noted earlier, weight gain recommendations are based on pre-pregnancy BMI, thus analyses were repeated for each BMI weight class. Women who were classified as having a normal BMI \((n = 66)\) prior to pregnancy reported estimates of recommended weight gain between 18 and 40 pounds \((M = 28.82, SD = 5.17)\), which is not significantly different from the recommended guidelines \((p = 0.07, d = -0.23)\). Women with a pre-pregnancy BMI in the
overweight range \((n = 37)\) reported needing to gain between 10 and 38 pounds during pregnancy \((M = 25.89, SD = 5.44)\), which is higher than what is recommended \((t(36) = 6.58, p < 0.001, d = 1.08)\). Similarly, women with a BMI in the obese range \((n = 43)\) reported estimates of recommended weight gain ranging from 10 to 60 pounds \((M = 22.23, SD = 10.17)\), which is more than the guidelines published by the IOM \((t(42) = 4.35, p < 0.001, d = 0.66)\).

**Weight- and Diet-Related Knowledge in a Pregnant and Comparison Sample**

Univariate analyses explored whether knowledge in women who are pregnant is more accurate than the convenience comparison sample. A series of independent t-test examined differences between pregnant women and undergraduates as well as gender differences between undergraduate males and undergraduate females. Results indicate a significant difference between pregnant women and undergraduates, both in their estimates of the amount of additional calories needed during pregnancy, \(t(699) = -4.07, p < 0.001, d = 0.39\), and suggested weight gain, \(t(715.33) = -4.85, p < 0.001, d = 0.31\). For caloric intake, the combined sample of pregnant women reported a mean additional intake of 679.17 calories per day \((SD = 746.61)\), whereas the comparison sample reported a mean intake of 1006.97 calories per day \((SD = 925.31)\). Moreover, expecting women had more accurate knowledge of weight gain \((M = 26.43, SD = 7.67)\) compared to the comparison sample \((M = 33.54, SD = 31.82)\). Univariate analyses did not indicate any significant difference in knowledge between undergraduate females and undergraduate males (all \(p’s > 0.05\)).

**Role of Knowledge in Excess Gestational Weight Gain**

Regression analyses examined if lack of knowledge predicts excess gestational weight gain. Preliminary analyses showed a difference in knowledge as compared to recommended guidelines between BMI classes. Therefore, pre-pregnancy BMI was included in the full
regression as a covariate. The regression of knowledge of caloric intake and weight gain during pregnancy on excess gestational weight gain was not significant ($F(3, 35) = 1.06, p = 0.38, R^2 Δ = 0.08$). In addition, neither knowledge of caloric intake or weight gain emerged as significant predictors of excess weight gestational weight gain (both $p$’s > 0.05).

**Discussion**

The aim of this study was to examine accuracy of knowledge regarding caloric intake and weight gain during pregnancy in both a pregnant population and a comparison sample. A secondary aim was to identify if knowledge of weight gain and caloric intake is predictive of excess gestational weight gain at the end of pregnancy.

The women in the current study appear to have more accurate knowledge regarding prenatal intake and weight gain than the comparison sample. This is to be expected and is consistent with previous research. While undergraduate students have accurate information regarding conception and pregnancy issues related to substance use and preconception health, low levels of knowledge have been indicated regarding prenatal health and development (Crusenberry, Colby, Spence, Murphy, & Kavanagh, 2016; Delgado, 2008) and appropriate rate of pregnancy weight gain (Crusenberry et al., 2016). In the current study, there were no significant gender difference when comparing females to males in the comparison sample. These findings add to the discrepancy in published literature, with some studies showing a significant difference in knowledge regarding pregnancy related health behaviors between males and females (Delgado, 2008) and others showing no difference (Crusenberry et al., 2016).

Regardless of trimester, women appear to have inaccurate knowledge of how many additional calories are required during pregnancy. This lack of knowledge could be attributed to the misconception that pregnancy is a time to “eat for two,” which has taken on moral
significance in our culture, such that eating a “healthy” amount during pregnancy is seen by some as indicative of being a good mother (Copleton, 2007). The tendency to eat more than what is needed appears to begin early in pregnancy, with respondents in the first trimester already reporting needing an additional 100 to 2300 calories per day. While this is concerning given that no additional caloric intake or weight gain is recommended during the first 12 weeks of pregnancy (Wolfram, 2017), it is also expected given that women in their first trimester don’t often have regular, or at times any, contact with their health care provider. This is particularly true for our sample, with less than 20% of women recruited from the local medical center reported being in their first trimester, and of those 20% (n = 15), five women were in their 12th week, and all women were at least eight weeks’ gestation.

Consistent with previous research there appears to be an association between a deficit in the knowledge expecting women have regarding the amount of weight they should gain and their pre-pregnancy weight class (Shulman & Kottke, 2016; Tovar et al., 2010). In our sample, women with a normal BMI prior to pregnancy had knowledge of weight gain that was consistent with IOM guidelines. However, women with a BMI in the overweight and obese range prior to the onset of pregnancy reported estimates of recommended weight gain that is significantly different from published recommendations. The current study did not assess whether women had received weight gain and nutrition information from their provider, thus it is not possible to discern from the results whether the differences in knowledge and recommendations are due to not receiving information or from receiving inaccurate information. However, previous literature has demonstrated that even when women in the higher weight classes receive education regarding gestational weight gain, the information is often inaccurate (Tovar et al., 2010). In Tovar et al.’s (2010) qualitative study, when asked about weight gain recommendations, one woman in the
overweight/obese group responded with “something like five pounds a month or something like that, I forgot, they say like 35 pounds that you can gain?” Our findings are thus consistent and in support of previous research showing that women who are at high risk for excess gestational weight gain due to pre-pregnancy weight class lack appropriate information, whether due to not receiving it or what they receive is inaccurate.

Our findings suggest that there is a general lack of knowledge regarding weight and eating in pregnancy, with our non-pregnant respondents having significantly less knowledge than pregnant women do. Given that the majority of pregnancies in the United States are unplanned this demographic is perhaps the most vulnerable to problematic health-related behaviors during pregnancy (Power et al., 2006). In addition, and as evidenced by our findings, women who do become pregnant do not always receive prenatal care during the first weeks of gestation. Therefore, dissemination should take a public health approach, rather than happen on the individual level (i.e., for women who are already pregnant and already receiving prenatal care). There is some evidence for the effectiveness of a college course in preconception health and prenatal development in increasing knowledge, with awareness rates regarding positive and negative factors influencing pregnancy increasing from 13% at the beginning of the course to 93% at the end of the course (Delgado, 2013). However, not all women who become pregnant attend college. This is particularly relevant for our sample of pregnant women, with 25% reporting high school or the equivalent as their highest level of education. Therefore, a class offered at the college level may benefit only a small portion of those who become pregnant. Thus, we maintain that a public health approach to information dissemination of appropriate knowledge and recommendations is warranted.
While inaccurate knowledge is prevalent in our pregnant population, we were not able to
detect an effect of this lack of knowledge on excess gestational weight gain. Neither knowledge
of caloric intake or appropriate weight gain emerged as significant predictors of excess weight
gain at the end of pregnancy. These findings are inconsistent with previous research showing that
low health literacy is a significant predictor of excess weight gain (Shulman & Kottke, 2016).
There are a number of explanations for the lack of significant findings in this study. Firstly, our
analysis was preliminary and lacked adequate power. Therefore, it is plausible that an association
does exist; however, our design was not fully powered to detect an effect. Secondly, other factors
are likely accounting for a more significant portion of the variance in excess gestational weight
gain. For example, eating healthy, even with appropriate knowledge, may not be feasible for
low-income families. A lack of financial resources is a likely factor, especially in our hospital
sample, with 37.5% of those respondents reporting individual yearly incomes at or below
$10,000 and nearly half of the sample reporting household yearly incomes below $30,000.
Other potential factors have been highlighted elsewhere (Orloff & Hormes, 2014), including the
effect of food cravings on excess gestational weight gain both in a cross-sectional (Orloff et al.,
2016) and longitudinal design (See Study 2). Future studies should continue to track cravings, as
well as other potential factors contributing to maladaptive eating during pregnancy such as
access to healthy foods, appropriate diet/nutrition knowledge, and pre-existing disordered eating
behaviors (Orloff & Hormes, 2014).

Limitations

There are several other important limitations to this study. Primarily, our knowledge
questions did not ask women to answer based on current trimester and pre-pregnancy BMI.

9 2018 Federal poverty line is $12,140 for individuals (healthcare.gov).
However, review of the open-ended answers indicates that some women did respond based on their own trimester and pre-gravid BMI. In addition, women were instructed to answer the questions about what they know, not necessarily what they are doing, thus the role of knowledge in predicting weight gain is not necessarily indicative of behavior. Future research should be more explicit in comparing knowledge to actual behaviors, and whether other factors, such as food cravings, override knowledge.

In the current study, analyses examined weight gain knowledge based on pre-pregnancy BMI. It has been demonstrated that self-reported BMI is often lower than physician measured BMI (Callaway, O’Callaghan, & McIntyre, 2009; McAdams, Van Dam, & Hu, 2007), and that this is particularly true for women in the overweight and obese category (Callaway et al., 2009). Therefore, it is hard to discern how accurate the analyses are because pre-pregnancy BMI was based on self-report and thus subject to potential bias. Accurate pre-gravid weight data from medical records or other medical documents would be a benefit in future studies aimed at expanding on the current findings.

Limitations that are more global include the absence of weight gain recommendations for women with short stature, adolescents, or members of racial/ethnic minority groups. Evidence shows that these factors are not significant moderators between gestational weight gain and outcomes of pregnancy, however, the data supporting these findings is somewhat limited (Rasmussen & Yaktine, 2009). This is notably important given the diverse makeup of our sample, with over 25% identifying as a member of an ethnic minority. Additionally, guidelines are only available for women with BMI in the underweight, normal, overweight, and obese categories. Current recommendations do not differentiate between women whose pre-gravid weight falls in the obesity class II (BMI 35 kg/m² to 39.9 kg/m²) or III (BMI ≥ 40 kg/m²), which
is a limitation considering the proportion of women falling in the latter class is steadily increasingly (Ogden et al., 2006). Close to one quarter of our sample reported BMIs in the obese range, with 13.2% of them reporting BMIs classified as obesity II (5.2%) or III (5.6%). Future guidelines should be adjusted to account for ethnicity, age, and expanded weight ranges. This is particularly important given the research showing that women in the higher weight classes are at the greatest risk for excess gestational weight gain (Rasmussen et al., 2009).

Conclusion and Future Directions

The results of the current study add to existing literature showing that expecting mothers and the general population lack appropriate knowledge regarding nutrition and weight gain during pregnancy. The findings provide insight into areas that require further investigation and targets for intervention. A lack of knowledge appears widespread; suggesting dissemination at a more global level is warranted. However, if fully powered studies replicate our findings of a lack of association between knowledge and excess weight gain, this suggests that educational interventions will have limited effectiveness. Future research should seek to identify other psychosocial variables predictive of excess gestational weight gain and ones that may override knowledge and intention, which could be targets of novel interventions.
Study 4: 

Food Cravings in the Peri- and Post-Partum: Types, Frequency, and Association with Weight Retention

Introduction

Available literature indicates that food cravings typically emerge in the early stages of pregnancy, with a marked increase in frequency and intensity in the second trimester, followed by tapering as pregnancy progresses (Bayley et al., 2002; Pope et al., 1992). Prior research also points to temporal patterns in the types of food craved, with savory substances being the most craved early on in pregnancy (Belzer et al., 2010), preference for sweet foods reaching peak intensity during the second trimester (Bowen, 1992), and urges for salty substances emerging later in pregnancy (Bowen, 1992; Crystal et al., 1999; Skinner et al., 1998). Cravings in the post-partum, the time-period of approximately six to eight weeks following delivery, are significantly understudied, with limited – and, at this point, largely outdated - evidence suggesting that food cravings remit by the end of pregnancy (Harries & Hughes, 1958; Marcus, 1964).

As stated in more detail elsewhere, the exact causes of food cravings in pregnancy are unclear (Orloff & Hormes, 2014). Biologically driven hypotheses suggest that hormones and/or nutritional deficits are the cause of food cravings in pregnancy. These hypotheses predict a decrease in cravings immediately following pregnancy and continuing well into the later stages of the post-partum. Unfortunately, the scarcity of available data that examines the presence of cravings in the post-partum tends to do so in the context of another factor, such as breastfeeding (Worthington-Roberts et al., 1989) or gestational diabetes (Belzer, Smulian, Lu, & Tepper, 2010). Worthington-Roberts and colleagues (1989) hypothesized that lactators (i.e., women who nursed for at least three months) would experience more physiological and endocrine changes
due to breastfeeding and therefore report more frequent food cravings. This hypothesis would be consistent with the assumption that cravings, in general, are due to a change in body chemistry. However, contrary to their initial hypothesis, the authors found that non-lactators (i.e., women who never initiated lactation, or stopped nursing by one-month post-partum) endorsed a higher frequency of cravings in the late stages of pregnancy and the post-partum. Additionally, Belzer (2010) showed that women with gestational diabetes endorsed significantly higher frequency of sweet cravings in the late stages of pregnancy (34 – 38 weeks), followed by less frequent cravings (overall) in the post-partum as compared to non-diabetic respondents. The work done by Worthington- Roberts (1989) and Belzer (2010) suggests the need to test alternative hypotheses, including the notion that cravings are driven by cognitive and cultural factors.

Framed in the context of EI Theory, it is probable that the dietary restrictions enforced during this time for women with gestational diabetes increases feelings of deprivation (Weingarten & Elston, 1991), and that the avoidance leads to greater attention to and elaboration on thoughts (“I want it, but I can’t have it”), and ultimately intensifies the craving. EI Theory predicts that once the restrictions are lifted after pregnancy there is a decrease in the conflict between approach/ avoidance and subsequently a decrease in frequency of craving. However, empirical evidence to support these assumptions is limited.

Research on type and frequency of cravings in the post-partum is lacking, as is data on the potential impact of craving on weight retention following delivery. Research consistently demonstrates that women who gain excess gestational weight are at greater risk for post-partum weight retention, compared to those who gain within the recommended range (Baker et al., 2008; Hediger, Schall, Ances, & Smith, 1995; Siega-Riz et al., 2009). Successful weight loss in the post-partum appears to be attributable to breastfeeding (Baker et al., 2008), though this is not
equivocal (Ohlin & Rossner, 1990; Rooney & Schaubberger, 2002). The lack of consistency in findings is likely due to the interaction of additional factors that would disrupt the effect of breastfeeding. Variables such as length and exclusivity of breastfeeding, pre-pregnancy BMI (Baker et al., 2008), age, and smoking cessation (Ohlin & Rossner, 1990) are a few factors that likely affect the rate of weight loss following delivery. This suggests that there is a portion of variance in weight retention that is not accounted for. We previously reported that food cravings are a significant predictor of excess gestational weight gain, accounting for an especially substantial portion of the variance in women with overweight or obesity prior to pregnancy (See Study 2; Orloff et al., 2016). Thus, we hypothesize that given their causal impact on gestational weight gain, food cravings in the post-partum play a role in excess weight retention.

**Study Aims**

The nature of cravings in the post-partum and their potential effect on weight retention following delivery lacks sufficient study. This study was designed to explore the types and frequency of food cravings reported by women in the peri-partum, and evaluate changes in the nature of cravings across and following pregnancy. A secondary aim was to assess the effect of peri-partum cravings on post-partum weight retention. To our knowledge, this is the first study to investigate this association. The findings from this study have important implications regarding intervention to reduce weight retention following delivery, especially in women who gain excess weight during pregnancy.

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10 The term peri-partum is commonly used to refer to the time shortly before, during, and immediately after (usually four weeks) delivery. Here, “peri-partum” was defined as capturing the six weeks following delivery and delineate that time-period from the post-partum, which is defined as eight to 125 weeks after delivery in the current study. Six weeks following delivery is a sufficient time to assess cravings given research showing that a plethora of interventions started during pregnancy often continue into six weeks following delivery (Lavender, Richens, Milan, Smyth, & Dowswell, 2011).
Methods

Participants and Procedures

Participants were pregnant women receiving routine prenatal care at the Department of Obstetrics, Gynecology, and Reproductive Sciences at a local academic medical center. Participants were originally recruited into a longitudinal study of food cravings and other eating behaviors and their impact on weight gain in pregnancy (See Study 2). Participants provided consent to complete a self-report survey up to four times, corresponding to the three trimesters of pregnancy and the post-partum. Eligible participants were contacted via the email address they provided during the consent process when they were at least six weeks post-partum to inquire about continuing their participation in the study.\(^{11}\) The Institutional Review Boards at Albany Medical Center and the University at Albany, State University of New York approved the addition of a post-partum follow-up survey to the original study protocol. The surveys were accessible via a link to the secure online service Survey Monkey and utilized the same interface as the three questionnaires completed during pregnancy.

Measures

Demographics. Women \((n = 71)\) were contacted via email between October 2017 and January 2018. Women who consented at the start of the study, but did not complete a full questionnaire at time point one \((n = 14)\) or women who were not at least six weeks post-partum \((n = 3)\) were excluded from participating in this portion of the study and not contacted during this wave of data collection. Of the women contacted, 46.5% \((n = 33)\) responded and agreed to

\(^{11}\) Women recruited before July 2017 provided additional consent to complete the fourth time point questionnaire, as this time point was not included in the original consent. To protect confidentiality, patients were not required to give any identifying information in the consent. In order to link previous responses with the fourth time point questionnaire, patients who agreed to complete the post-partum questionnaire were reminded of their original ID number, which they entered in after consenting.
complete the post-partum questionnaire. At the time of survey completion, women were between eight and 125 weeks post-partum ($M = 61.08, SD = 38.57$). Women provided information regarding their current weight to allow us to calculate estimates of post-partum weight retention at the time of survey completion.

**Food Craving Inventory (FCI; White et al., 2002).** Please see detailed description provided in Study 1 (pp. 25). In the current sample, the FCI demonstrated good reliability for the “frequency” (total: Cronbach’s $\alpha = 0.92$; factors: “high fat foods” Cronbach’s $\alpha = 0.82$; “sweets” Cronbach’s $\alpha = 0.88$; “carbohydrates/starches” Cronbach’s $\alpha = 0.81$; and “fast food fats” Cronbach’s $\alpha = 0.68$) and “giving in” scales (total: Cronbach’s $\alpha = 0.92$; factors: “high fat foods” Cronbach’s $\alpha = 0.87$; “sweets” Cronbach’s $\alpha = 0.87$; “carbohydrates/starches” Cronbach’s $\alpha = 0.80$; and “fast food fats” Cronbach’s $\alpha = 0.62$).

**Statistical Analysis**

Paired samples t-test were used to examine differences in craving during pregnancy, the peri-partum (i.e., the six week-period following delivery), and the post-partum (i.e., eight weeks to 125 weeks following delivery). The hypothesized impact of peri-partum food cravings on post-partum weight retention was examined using multiple linear regression analyses, with FCI subscale scores as the predictors, excess post-partum weight retention as the dependent variable, and weeks since delivery and pre-pregnancy BMI as covariates. Based on research showing that women who have a pre-pregnancy BMI greater than $25.00 \text{ kg/m}^2$ are more at risk of excess weight retention in the post-partum, the regression analyses were repeated in women with overweight or obesity prior to the onset of pregnancy (Baker et al., 2008; Hediger et al., 1995; Siega-Riz et al., 2009). Excess weight retention at time of survey completion was calculated by subtracting current self-reported weight from self-reported pre-pregnancy weight. The suitability
of the data for regression analysis was determined by examining homoscedasticity, normality, and multi-collinearity. Assumptions were met and VIF factors were below 5.00. Post-hoc power analyses suggested that the study was underpowered at 0.20 for the multiple regression, thus these analyses should be interpreted with caution.

**Results**

**Descriptive Statistics**

The majority of the sample identified as White (66.7%, \( n = 22 \)), 18.2% (\( n = 6 \)) of respondents were African American/ Black, 12.1% were Asian (\( n = 4 \)), and 3.0% were Hispanic/ Latino (\( n = 1 \)). Ages at time of post-partum questionnaire completion ranged from 18 to 43 (\( M = 31.79, SD = 6.01 \)). The majority of the sample (75.8%, \( n = 25 \)) provided consent to have information extracted from their medical records, including their weight at the final hospital visit before delivery. Of the women for whom this information was available, 40.0% (\( n = 10 \)) had gained within five pounds above or below the recommended guidelines at their final prenatal visit, 36.0% gained (\( n = 9 \)) at least five pounds more than what was recommended, and 24.0% (\( n = 6 \)) had insufficient weight gain (i.e., at least five pounds below recommendations). There was not a significant difference between pre-pregnancy (\( M = 30.48, SD = 9.31 \)) and post-partum BMI (\( M = 31.66, SD = 9.06 \)) (\( t(32) = -1.71, p > 0.05, d = -0.13 \)).

When assessed during the post-partum, 46.9% (\( n = 15 \)) of respondents were classified as obese, 37.5% (\( n = 12 \)) as overweight, 12.5% (\( n = 4 \)) as normal weight, and 3.1% (\( n = 1 \)) as underweight. Over one third of the sample (36.4%, \( n = 12 \)) was breastfeeding at the time of survey completion, with the remaining 63.6% (\( n = 21 \)) reporting having breastfed previously, but not currently. Length of breastfeeding ranged from three days to 20 months. Reasons for
discontinuing breastfeeding included difficulty latching, decreased milk production, allergies, as well as planned discontinuation.

**Craving during Pregnancy, the Peri-partum, and the Post-partum**

During pregnancy, women rated cravings for and consumption of “fast foods” and “sweets” in response to cravings as the most common (Figure 3). The most frequent cravings during pregnancy were for “pizza” \((M = 2.97, SD = 1.06)\), “chocolate” \((M = 2.94, SD = 1.27)\), and “ice cream” \((M = 2.81, SD = 1.12)\). Women rated the “frequency” of their peri-partum cravings and indicated the highest cravings for “fast foods” and “sweets,” and endorsed cravings for “carbohydrates/starches” and “high fat foods” somewhat less frequently (Figure 3). In the six weeks following pregnancy women reported “giving in” to cravings for “fast foods” and “sweets,” more often than cravings for “carbohydrates/starches” and “high fat foods” (Figure 4). The most frequent cravings during the peri-partum were for “chocolate” \((M = 2.66, SD = 1.38)\), “ice cream” \((M = 2.59, SD = 1.34)\), and “pizza” \((M = 2.47, SD = 1.19)\). These trends were sustained into the post-partum, with women rating their current “frequency” of cravings highest for “fast foods” and “sweets,” specifically “chocolate” \((M = 2.97, SD = 1.21)\), “pizza” \((M = 2.79, SD = 1.02)\), and “pasta” \((M = 2.54, SD = 1.00)\) (Figure 3). They also reported giving into cravings for “fast foods” and “sweets” most often (Figure 4).

Paired samples t-test compared frequency of craving reported during pregnancy to craving frequency during the peri-partum. Total FCI scores (“frequency,” \(t(18) = 0.39, p = 0.21\), and “giving in,” \(t(23) = 0.44, p = 0.21\) were not significantly different across the two time points. In addition, “frequency” of and “giving in” to cravings for the four separate categories of food did not differ significantly across pregnancy and into the peri-partum (all \(p’\)s > 0.05). Post hoc analyses indicated that there was a small effect \((d = 0.28)\) for “frequency” and “giving in” \((d = 0.28)\).
Similarly, there was no significant difference in the subjective ($t(26) = -1.12, p = 0.27, d = 0.17$) or behavioral ($t(22) = -0.55, p = 0.59, d = 0.09$) report of craving between the peri-partum and the post-partum.

**The Association between Peri-partum Food Craving and Post-partum Weight Retention**

Multiple linear regression examined whether peri-partum food craving is associated with post-partum weight retention. Neither the subjective nor behavioral report of craving accounted for a significant portion of unique variance in weight retention (“frequency” $F(6, 22) = 1.16, p = 0.26, R^2_\Delta = 0.07$; “giving in” $F(6, 21) = 0.67, p = 0.68, R^2_\Delta = 0.01$).

The impact of craving on post-partum weight retention was examined in the subset of women with a pre-pregnancy BMI in the overweight or obese range ($n = 20$). Similar to the regression for the full sample neither “frequency” ($F(6, 11) = 0.80, p = 0.59, R^2_\Delta = 0.06$) nor “giving in” ($F(6, 11) = 0.50, p = 0.80, R^2_\Delta = 0.04$) to cravings during the peri-partum significantly impacted excess weight retention.

**Discussion**

The current study had two primary aims. The first was to examine the type and frequency of food cravings following delivery, as compared to cravings reported in gestation. Findings from the current study show that women experience a slight drop off in cravings following delivery, though difference between cravings during pregnancy and in the peri-partum were not statistically significant. In addition, we compared the report of craving in the six weeks following delivery to current (i.e., at the time of survey completion) post-partum cravings. The rationale for this analysis was 1) we wanted to identify if the decrease in cravings continues throughout the post-partum, which would be consistent with the biologically driven hypotheses of cravings, and 2) we wanted to establish that women did differentiate between their retrospective report of peri-
partum cravings and current report of post-partum cravings. There were differences between peri – and post-partum reports of craving (suggesting that women seriously thought about past cravings in their retrospective reports on their peri-partum experience), though these were not statistically significant. With the exception of “high fat foods”, women further along in the post-partum reported more frequent cravings than they had experienced in the peri-partum. Conversely, women in the peri-partum reported giving in to cravings more frequently, as compared to women in the later stages of the post-partum.

Perhaps the most important finding from the study is the consistency of craving across pregnancy, following delivery, and into the post-partum. Women reported the highest cravings for “pizza,” “ice cream,” and “chocolate” during pregnancy and in the peri-partum, and for “pizza,” “ice cream,” and “pasta” in the post-partum. The stability of type and frequency of craving across time are inconsistent with literature showing a drop off in cravings after the second trimester (Bayley et al., 2002; Harries & Hughes, 1958; Pope et al., 1992). However, the findings do suggest that cravings are not attributable to hormonal, endocrine, or other biological fluctuations that are unique to the context of pregnancy. These findings are further consistent with theoretical frameworks, like EI Theory, and our overarching hypothesis that the mechanisms underlying cravings are likely psychological and/or cultural in nature.

In addition to the findings showing the stability of cravings into the peri-partum, this study aimed to replicate our previous model, exploring the association between food craving and excess weight. Dissimilar to published cross-sectional (Orloff et al., 2016) and preliminary longitudinal results (Study 2) showing an effect of craving on excess gestational weight gain; neither subjective nor behavioral reports of craving were significant predictors of excess weight retention in the post-partum. This finding is interesting given the results showing a lack of drop
off in cravings during this time. There are likely a number of reasons for this lack of significance. The study was preliminary and power was low, thus findings must be interpreted with caution. However, one could speculate that if this lack of association remains in a sufficiently powered sample, then the lack of significance may be explained by Baker’s (2008) hypothesis that many factors, such as breastfeeding, influence weight retention in the post-partum.

**Limitations**

Perhaps the most significant limitation in the current study is sample size. Unfortunately, our study had a large rate of attrition between initial enrollment in the study and post-partum follow-up, resulting in a small sample size and low statistical power. Our null findings may thus be due to the lack of power and increased type II error. Future research should aim to replicate the aims of this study in a fully powered design to determine with more certainty the nature of the association between craving in the peri-partum and risk of post-partum weight retention.

As demonstrated in Study 1, the use of the FCI in this population requires further consideration. We were unable to replicate the original factor structure of the 28-item inventory in our sample of pregnant women. While many factors could account for the lack of fit, we posit that perhaps the FCI does not accurately capture all food cravings endorsed by pregnant women, as evidenced by our post-hoc analyses detailed in Study 1. Therefore, while the FCI is a widely used and validated measure, the extent to which it is appropriate for our population remains to be elucidated.

Additionally, the accuracy of craving report, even in measures that have been empirically validated, is a limitation. This limitation is explained in detail elsewhere (See Study 2, pp. 44). Beyond the lack of accuracy associated with retrospective report of craving the current study
asked about peri-partum cravings in the six weeks following delivery, however, no woman was currently in the peri-partum at the time of survey completion. Notably, our findings showed that there were differences between peri- and post-partum report of craving suggesting that women did not simply indicate the same responses for “current” and “peri-partum” craving but appeared to have made an honest effort to recall their experiences with regard to food craving. While our analyses showed that women did indeed report differences between peri-partum and current post-partum cravings, the accuracy with which they reported is unclear. To examine the temporal nature of cravings, future studies should collect data more systematically, that is, in women who are in the peri-partum, and in time increments delineated a priori.

**Conclusion and Future Directions**

The insufficient power attained in the current study suggests that this is an area requiring further exploration. While the results are preliminary, research focused on eating habits during the peri- and post-partum should continue given how lacking this area currently is. One potential avenue is to update the literature looking at breastfeeding and food craving in the post-partum. An update is necessary for a number of reasons, the first being that, to our knowledge, there is only one study looking at this relationship (Worthington-Roberts et al., 1989). The second is that since the publication of the original study new, well-validated craving measures have been created (Cepeda-Benito et al., 2000; White et al., 2002). In preliminary analyses we found that women currently breastfeeding endorsed more cravings; however, the differences were not significant. Unfortunately, our analyses were not sufficiently powered, and in addition, all women reported initiating breastfeeding at some point. The implications from this type of research could inform how to best treat cravings and if interventions should differentiate women who are breastfeeding from those who are not.
A number of studies have focused on prevention and intervention of overweight and obesity during pregnancy (Asbee et al., 2009; Jeffries et al., 2009; Phelan et al., 2011; Vinter et al., 2011). Proposed interventions during this time include mindfulness and acceptance based therapies (Dalen et al., 2010; Forman & Butryn, 2015; Forman et al., 2007; Godfrey et al., 2015). The findings from this study, particularly the stability of cravings into the post-partum, should inform the development of treatments for reducing weight retention following delivery. With the lack of drop off in craving frequency and empirical support for a role of psychological and culture influences on craving, application of already effective treatments for craving to women in the post-partum is warranted. In addition to mindfulness and acceptance, incorporation of low-calorie, vegan, and diabetic diets have been effective in reducing cravings in non-pregnant women (Barnard et al., 2009; Harvey, et al., 1993; Martin, et al., 2006). As stated elsewhere, these interventions may not be appropriate for expecting women, however, they should be considered as a possible avenue of intervention in post-partum women. Finally, the stability of cravings throughout pregnancy and into the post-partum suggest that interventions delivered during pregnancy to target excess gestational weight gain could potentially have continued benefit well after delivery.
General Discussion

With nearly half of all pregnancies in the U.S. currently resulting in excess gestational weight gain, the Institute of Medicine made a necessary call for researchers to identify psychosocial predictors that could serve as targets for novel prevention and treatment interventions (Oken et al., 2007; Rasmussen & Yaktine 2009; Wrotniak et al., 2008). Weight of the fetus, placenta, and amniotic fluid all account for some portion of the variance in excess gestational weight gain, however a larger portion of the variance is due to an increase in fat mass (Rasmussen & Yaktine, 2009). The role of food cravings had been significantly understudied in an expecting population, even though research shows that pregnancy is one of the two times (with the other being the perimenstrum) in a woman’s life she is likely to experience an overall increase in food craving (Pope et al., 1992). Craving has previously been shown to be a powerful trigger of over- and binge consumption and to play a role in overweight/obesity. Our own pilot work suggests a possible role of food cravings in excess gestational weight gain (Orloff et al., 2016). We sought to expand upon these findings and hypothesized that food cravings account for a significant portion of the variance in excess weight gain in pregnancy.

Many hypotheses have been proposed to explain the prenatal increase in food craving, with the majority pointing to an underlying biochemical cause, such as changes in hormones, nutritional deficits, or the palliative nature of certain ingredients in the craved foods (Orloff & Hormes, 2014). We previously documented a lack of evidence supporting a biochemical cause and proposed that the etiology of food cravings is related to cognitive and cultural factors. We sought to begin to test the predictions of the Elaborated Intrusion Theory of craving etiology specifically in pregnancy. EI Theory conceptualizes craving as a largely cognitively motivated state, brought on by internal or external cues that trigger automatic thoughts about the target
food, which are then elaborated upon in a manner that maintains and intensifies the craving episode (Kavanagh et al., 2005).

The specific goals of the studies presented here were to 1) establish the appropriateness of existing measures to assess key constructs in the context of EI Theory, including food cravings, restraint eating, emotional eating, and external eating in pregnant respondents, 2) establish a causal effect of food craving on excess gestational weight gain, 3) examine whether knowledge is a predictor of excess weight gain, and 4) explore the type, frequency, and impact of cravings during the postpartum.

Our findings indicate that the available measures used to assess eating behaviors (i.e., restrained eating, emotional eating, external eating, and food cravings) may not be appropriate for pregnant women. The lack of fit is explained in detail elsewhere, but what does require mentioning is the more frequent endorsement and consumption of food cravings that are not included in the measures we used in the current studies. We found that while women do endorse high cravings for “sweets” and “fast food fats,” the items included on the FCI might not be highlighting the “healthier” foods that women are craving and consuming, such as “fruits” and “vegetables.” We were able to replicate and expand upon the findings from our cross-sectional study (Orloff et al., 2016) and provide support for previously published qualitative studies (Anderson et al., 2015). We found that food cravings are a significant predictor of excess gestational weight gain and that these effects are especially pronounced in an overweight and obese population. Our work also adds to the limited research examining the role of cravings throughout pregnancy and into the post-partum. We were able to demonstrate stability regarding the type and frequency of cravings throughout pregnancy and into the peri- and post-partum, contesting claims of a biochemical etiology and providing further support for a cognitive and
cultural conceptualization of craving. However, we do recognize that multiple factors contribute to excess weight gain in pregnancy. Therefore, we examined the role of knowledge in our sample to identify if increased weight gains are associated with inaccurate knowledge about what is appropriate when it comes to prenatal diet and weight. While expecting women did provide more accurate estimates of recommended caloric intake and weight gain compared to the comparison sample, their knowledge was inconsistent with published guidelines. Unfortunately, we were unable to establish a relationship between knowledge and gestational weight gain or between cravings in the peri-partum and post-partum weight retention. As detailed elsewhere, these preliminary studies were underpowered and require replication to establish whether a true association exists.

Taken together, the outcomes from these studies provide a basis for the development and application of treatment interventions to interrupt the mechanisms underlying excess weight gain. The first is a move towards dissemination of knowledge, not at the individual level, but rather on a more global scale. If women are behaving in line with what they report, we can conclude that they are increasing their intake early in the first trimester, which is inconsistent with what is recommended, though expected since this is a time when women may not yet be receiving routine prenatal care. Therefore, waiting for women to receive education from their provider may be too late in effectively preventing excess weight gain.

Other targets for intervention include food cravings. As stated, many interventions targeting prenatal diet or physical activity in the prevention of overweight and obesity in pregnancy have not been successful (Asbee et al., 2009; Jeffries et al., 2009; Phelan et al., 2011; Vinter et al., 2011). Thus, our findings support the implementation of treatments that effectively disrupt the process of cognitive elaboration that is hypothesized to maintain craving (Kavanagh
et al., 2005). Techniques such as mindfulness and acceptance-based interventions aim to increase the awareness and acceptance of the craving and one’s emotional state (Forman & Butryn, 2015). In non-pregnant samples, this increase in awareness and acceptance has been shown to effectively interrupt the elaboration process and reduce the urge to attend to and elaborate on the craving (i.e., a decrease in seeking out relevant information, internal stimuli, or external stimuli). Consistent with Kavanagh’s (2005) theory, this should decrease intrusive thoughts about the food and reduce the intensity of the craving. We hypothesize that these interventions will be helpful in reducing the frequency and intensity of craving across pregnancy and into the post-partum and believe that this may have an added benefit of preventing excess weight retention following delivery.

There is still a significant amount of work to be done in this field. The poor fit of data from pregnant women with the proposed factor structure of measures commonly used to assess food cravings and eating behaviors requires further attention. Researchers should consider modifying these measures for a pregnant population, for example, by adding items commonly craved in pregnancy (i.e., fruit and vegetables) to the existing inventories. Expanding the findings from the current study into the post-partum also requires further investigation. Fully powered designs are necessary to explore how factors such as breastfeeding, craving, and pre-pregnancy disordered eating interact to predict weight retention in the post-partum. Continued efforts to answer the IOM’s call to identify predictors of excess gestational weight gain will highlight the significance that contextual, cultural, and psychological factors have on eating behaviors during pregnancy. Furthermore, these efforts will serve to inform development of effective treatments to be delivered during what many consider a “teachable moment.”
References


knowledge of weight, weight gain, complications of obesity and weight management strategies in pregnancy. *BMC research notes, 6, 1.*


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Table 2
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*Review of medical records indicated that one woman delivered twins and one woman had a miscarriage
Table 3
Confirmatory Factor Analysis Standardized Regression Weights (Factor Loadings) for the Food Craving Inventory “Frequency” Subscale

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<th>Items</th>
<th>High Fat Foods</th>
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<th>Carbs./Starches</th>
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<td>FCI1 Fried Chicken</td>
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<td>Items</td>
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<tr>
<td></td>
<td>High Fat Foods</td>
<td>Sweets</td>
<td>Carbs./Starches</td>
<td>Fast Food Fats</td>
</tr>
<tr>
<td>FCI1</td>
<td>Fried Chicken</td>
<td>0.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCI2</td>
<td>Sausage</td>
<td>0.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCI3</td>
<td>Gravy</td>
<td>0.69</td>
<td></td>
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</tr>
<tr>
<td>FCI4</td>
<td>Fried Fish</td>
<td>0.48</td>
<td></td>
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<td>FCI5</td>
<td>Bacon</td>
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<td>FCI6</td>
<td>Corn Bread</td>
<td>0.61</td>
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<td>FCI7</td>
<td>Hot Dog</td>
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<td>FCI8</td>
<td>Steak</td>
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<td></td>
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<td>FCI9</td>
<td>Brownies</td>
<td></td>
<td>0.79</td>
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</tr>
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<td>FCI10</td>
<td>Cookies</td>
<td></td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>FCI11</td>
<td>Candy</td>
<td></td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>FCI12</td>
<td>Chocolate</td>
<td></td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>FCI13</td>
<td>Donuts</td>
<td></td>
<td>0.65</td>
<td></td>
</tr>
<tr>
<td>FCI14</td>
<td>Cake</td>
<td></td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>FCI15</td>
<td>Cinnamon Rolls</td>
<td></td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td>FCI16</td>
<td>Ice Cream</td>
<td></td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>FCI17</td>
<td>Rolls</td>
<td></td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>FCI18</td>
<td>Pancakes or Waffles</td>
<td></td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>FCI19</td>
<td>Biscuits</td>
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<td>0.73</td>
<td></td>
</tr>
<tr>
<td>FCI20</td>
<td>Sandwich Bread</td>
<td></td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>FCI21</td>
<td>Rice</td>
<td></td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>FCI22</td>
<td>Baked Potato</td>
<td></td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>FCI23</td>
<td>Pasta</td>
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<td>0.60</td>
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<td>FCI24</td>
<td>Cereal</td>
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<td>0.46</td>
<td></td>
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<td>FCI25</td>
<td>Hamburger</td>
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<td>0.56</td>
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<td>FCI26</td>
<td>French Fries</td>
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<td>0.79</td>
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<td>FCI27</td>
<td>Chips</td>
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<td>0.71</td>
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<td>FCI28</td>
<td>Pizza</td>
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<td></td>
<td>0.69</td>
</tr>
<tr>
<td>Item</td>
<td>Emotional Eating</td>
<td>External Eating</td>
<td>Restrained Eating</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>-----------------</td>
<td>------------------</td>
<td></td>
</tr>
<tr>
<td>DEBQ1</td>
<td>Do you have a desire to eat when you are irritated?</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ3</td>
<td>Do you have a desire to eat when you have nothing to do?</td>
<td>0.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ5</td>
<td>Do you have a desire to eat when you are depressed or discouraged?</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ8</td>
<td>Do you have a desire to eat when you are feeling lonely?</td>
<td>0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ10</td>
<td>Do you have a desire to eat when somebody lets you down?</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ13</td>
<td>Do you have a desire to eat when you are cross?</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ16</td>
<td>Do you have the desire to eat when you are approaching something unpleasant to happen?</td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ20</td>
<td>Do you get the desire to eat when you are anxious, worried, or tense?</td>
<td>0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ23</td>
<td>Do you have a desire to eat when things are going against you or when things have gone wrong?</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ25</td>
<td>Do you have the desire to eat when you are emotionally upset?</td>
<td>0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ28</td>
<td>Do you have a desire to eat when you are bored or restless?</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ30</td>
<td>Do you have a desire to eat when you are frightened?</td>
<td>0.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ32</td>
<td>Do you have a desire to eat when you are disappointed?</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ2</td>
<td>If food tastes good to you, do you eat more than usual?</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ6</td>
<td>If food smells and looks good, do you eat more than usual?</td>
<td>0.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ9</td>
<td>If you see or smell something delicious, do you have a desire to eat it?</td>
<td>0.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ12</td>
<td>If you have something delicious to eat, do you eat it straight away?</td>
<td>0.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ15</td>
<td>If you walk past the baker do you have the desire to buy something delicious?</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ18</td>
<td>If you see others eating, do you also have the desire to eat?</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ21</td>
<td>Can you resist eating delicious foods?</td>
<td>-0.13*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ24</td>
<td>If you walk past a snack bar or café, do you have the desire to buy something delicious?</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ27</td>
<td>Do you eat more than usual, when you see others eating?</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ33</td>
<td>When you are preparing a meal are you inclined to eat something?</td>
<td>0.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ4</td>
<td>If you have put on weight, do you eat less than you usually do?</td>
<td>0.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ7</td>
<td>How often do you refuse food or drink offered because you are concerned about your weight?</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ11</td>
<td>Do you try to eat less at mealtimes than you would like to eat?</td>
<td>0.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ14</td>
<td>Do you watch exactly what you eat?</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ17</td>
<td>Do you deliberately eat foods that are slimming?</td>
<td>0.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ19</td>
<td>When you have eaten too much, do you eat less than usual the following days?</td>
<td>0.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ22</td>
<td>Do you deliberately eat less in order not to become heavier?</td>
<td>0.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ26</td>
<td>How often do you try not to eat between meals because you are watching your weight?</td>
<td>0.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ29</td>
<td>How often in the evening do you try not eat because you are watching your weight?</td>
<td>0.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEBQ31</td>
<td>Do you take into account your weight with what you eat?</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p > 0.05
Table 6
Guidelines for Gestational Weight Gain, Based on Pre-Pregnancy Body Mass Index (Rasmussen & Yaktine, 2009)

<table>
<thead>
<tr>
<th>Pre-pregnancy BMI Category</th>
<th>Pre-Pregnancy BMI (kg/m(^2))</th>
<th>Recommended Weight Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>Less than 18.5 kg/m(^2)</td>
<td>28 to 40 lbs.</td>
</tr>
<tr>
<td>Normal Weight</td>
<td>18.5 kg/m(^2) – 24.99 kg/m(^2)</td>
<td>25 to 35 lbs.</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.00 kg/m(^2) – 29.99 kg/m(^2)</td>
<td>15 to 25 lbs.</td>
</tr>
<tr>
<td>Obese</td>
<td>30.00 kg/m(^2) or more</td>
<td>11 to 20 lbs.</td>
</tr>
</tbody>
</table>
Table 7
Multiple Linear Regression Model Estimating Associations between Excess Weight Gain and Scores on the Food Craving Inventory “Frequency” Subscales

<table>
<thead>
<tr>
<th></th>
<th>High Fats</th>
<th>Sweets</th>
<th>Carb./Starches</th>
<th>Fast Foods</th>
<th>Excess GWG</th>
<th>β</th>
<th>P</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Fats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.21</td>
<td>0.44**</td>
<td>0.64 0.001***</td>
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<tr>
<td>Sweets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.68***</td>
<td>0.62***</td>
<td>-0.19 -0.23 0.30</td>
</tr>
<tr>
<td>Carb./Starches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.64***</td>
<td>-0.15 -0.57 0.03*</td>
<td>-24.28, 1.80</td>
</tr>
<tr>
<td>Fast Foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.11</td>
<td>0.47 0.03*</td>
<td>0.90, 17.13</td>
</tr>
<tr>
<td>Mean</td>
<td>1.79</td>
<td>2.48</td>
<td>2.18</td>
<td>2.44</td>
<td>5.38</td>
<td></td>
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<tr>
<td>SD</td>
<td>0.64</td>
<td>0.88</td>
<td>0.65</td>
<td>0.78</td>
<td>14.89</td>
<td></td>
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</table>

\*p < 0.05, \*\*p < 0.01, \*\*\*p ≤ 0.001
Table 8
Multiple Linear Regression Model Estimating Associations between Excess Weight Gain and Scores on the Food Cravings Questionnaire- Trait

<table>
<thead>
<tr>
<th></th>
<th>Zero-Order r</th>
<th>Excess GWG</th>
<th>β</th>
<th>P</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INT</td>
<td>POS</td>
<td>REL</td>
<td>LOC</td>
<td>PRE</td>
</tr>
<tr>
<td>INT</td>
<td>0.67***</td>
<td>0.69***</td>
<td>0.70***</td>
<td>0.68***</td>
<td>0.49***</td>
</tr>
<tr>
<td>POS</td>
<td>0.91***</td>
<td>0.80***</td>
<td>0.78***</td>
<td>0.48***</td>
<td>0.81***</td>
</tr>
<tr>
<td>REL</td>
<td>0.79***</td>
<td>0.82***</td>
<td>0.50***</td>
<td>0.76***</td>
<td>0.65***</td>
</tr>
<tr>
<td>LOC</td>
<td>0.74***</td>
<td>0.41**</td>
<td>0.91***</td>
<td>0.62***</td>
<td>0.20</td>
</tr>
<tr>
<td>PRE</td>
<td>0.57***</td>
<td>0.67***</td>
<td>0.70***</td>
<td>0.18</td>
<td>0.13</td>
</tr>
<tr>
<td>PHY</td>
<td>0.37*</td>
<td>0.42**</td>
<td>-0.004</td>
<td>0.26</td>
<td>0.42</td>
</tr>
<tr>
<td>EMO</td>
<td>0.61***</td>
<td>0.08</td>
<td>0.38*</td>
<td>0.50</td>
<td>0.20</td>
</tr>
<tr>
<td>CUE</td>
<td>0.10</td>
<td>0.01</td>
<td>-0.38</td>
<td>0.07*</td>
<td></td>
</tr>
<tr>
<td>GUL</td>
<td>0.17</td>
<td>0.26</td>
<td>0.12</td>
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<tr>
<td>Mean</td>
<td>2.94</td>
<td>2.55</td>
<td>2.30</td>
<td>2.05</td>
<td>2.22</td>
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<tr>
<td>SD</td>
<td>1.18</td>
<td>1.10</td>
<td>1.21</td>
<td>1.04</td>
<td>1.18</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01, ***p ≤ 0.001

Intentions (INT), Positive Reinforcement (POS), Relief (REL), Lack of Control (LOC), Preoccupation (PRE), Physiological (PHY), Emotions (EMO), Cues (CUE), Guilt (GUL)
Table 9
*Multiple Linear Regression Model Estimating Associations between Excess Weight Gain and Scores on the Food Craving Inventory “Frequency” Subscales in Women with a Pre-Pregnancy BMI in the Overweight or Obese Range*

<table>
<thead>
<tr>
<th></th>
<th>Zero-Order $r$</th>
<th></th>
<th></th>
<th>Excess GWG</th>
<th>$\beta$</th>
<th>$p$</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Fats</td>
<td>Sweets</td>
<td>Carb./ Starches</td>
<td>Fast Foods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Fats</td>
<td>0.42*</td>
<td>0.59**</td>
<td>0.44*</td>
<td>0.55*</td>
<td>0.58</td>
<td>0.05</td>
<td>0.10, 29.15</td>
</tr>
<tr>
<td>Sweets</td>
<td>0.35</td>
<td>0.41</td>
<td></td>
<td>0.41</td>
<td>0.18</td>
<td>0.46</td>
<td>-8.97, 18.58</td>
</tr>
<tr>
<td>Carb./ Starches</td>
<td></td>
<td></td>
<td>0.47*</td>
<td>0.12</td>
<td>-0.44</td>
<td>0.12</td>
<td>-29.24, 3.79</td>
</tr>
<tr>
<td>Fast Foods</td>
<td></td>
<td></td>
<td></td>
<td>0.46*</td>
<td>0.35</td>
<td>0.18</td>
<td>-3.50, 16.31</td>
</tr>
<tr>
<td>Mean</td>
<td>1.75</td>
<td>2.10</td>
<td>2.10</td>
<td>2.31</td>
<td>10.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>0.56</td>
<td>0.53</td>
<td>0.49</td>
<td>0.76</td>
<td>14.14</td>
<td></td>
<td>$R^2 = 0.50$</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01, ***p ≤ 0.001
Table 10
Multiple Linear Regression Model Estimating Associations between Excess Weight Gain and Scores on the Food Cravings Questionnaire-Trait in Women with a Pre-Pregnancy BMI in the Overweight or Obese Range

<table>
<thead>
<tr>
<th></th>
<th>Zero-Order r</th>
<th>Excess GWG</th>
<th>β</th>
<th>P</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>INT</td>
<td>0.71***</td>
<td>0.90</td>
<td>0.01</td>
<td></td>
<td>-131.73, -18.94</td>
</tr>
<tr>
<td>POS</td>
<td>0.88***</td>
<td>0.81</td>
<td>0.06</td>
<td></td>
<td>-6.95, 162.50</td>
</tr>
<tr>
<td>REL</td>
<td>0.77***</td>
<td>0.50</td>
<td>0.13</td>
<td></td>
<td>-155.51, 9.07</td>
</tr>
<tr>
<td>LOC</td>
<td>0.85***</td>
<td>0.58</td>
<td>0.27</td>
<td></td>
<td>-16.05, 127.95</td>
</tr>
<tr>
<td>PRE</td>
<td>0.59**</td>
<td>0.49</td>
<td>0.95</td>
<td></td>
<td>-99.12, 67.82</td>
</tr>
<tr>
<td>PHY</td>
<td>0.52**</td>
<td>0.72</td>
<td>0.01**</td>
<td></td>
<td>28.61, 119.74</td>
</tr>
<tr>
<td>EMO</td>
<td>0.64***</td>
<td>0.92</td>
<td>0.16</td>
<td></td>
<td>-7.73, 159.00</td>
</tr>
<tr>
<td>CUE</td>
<td>0.17</td>
<td>-0.82</td>
<td>0.01**</td>
<td></td>
<td>-128.42, -30.12</td>
</tr>
<tr>
<td>GUL</td>
<td>0.18</td>
<td>0.20</td>
<td>0.20</td>
<td></td>
<td>-15.15, 60.95</td>
</tr>
</tbody>
</table>

Mean 0.39 0.35 0.28 0.26 0.23 0.41 0.28 0.34 0.32 8.59
SD 0.23 0.20 0.23 0.20 0.18 0.18 0.23 0.19 0.25 18.92

*p < 0.05, **p < 0.01, ***p ≤ 0.001

Intentions (INT), Positive Reinforcement (POS), Relief (REL), Lack of Control (LOC), Preoccupation (PRE), Physiological (PHY), Emotions (EMO), Cues (CUE), Guilt (GUL)
Figure 1
Food Craving Inventory: Four-Factor Structure (White et al., 2002)
Figure 2
Dutch Eating Behavior Questionnaire: Three-Factor Structure (Van Strien et al., 1986)
Figure 3
“Frequency” of Cravings during Pregnancy, the Peri-partum, and the Post-partum

<table>
<thead>
<tr>
<th></th>
<th>Pregnancy</th>
<th>Peri-partum</th>
<th>Post-partum</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
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<tr>
<td>“Frequency” Total</td>
<td>1.97</td>
<td>0.37</td>
<td>1.88</td>
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<tr>
<td>High Fat Foods</td>
<td>1.55</td>
<td>0.44</td>
<td>1.53</td>
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<tr>
<td>Sweets</td>
<td>2.22</td>
<td>0.71</td>
<td>2.08</td>
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<tr>
<td>Carbs/Starches</td>
<td>2.08</td>
<td>0.60</td>
<td>1.91</td>
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<tr>
<td>Fast Food Fats</td>
<td>2.39</td>
<td>0.66</td>
<td>2.19</td>
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</table>
Figure 4
Frequency of “Giving In” to Cravings during Pregnancy, the Peri-partum, and the Post-partum

<table>
<thead>
<tr>
<th></th>
<th>Pregnancy</th>
<th>Peri-partum</th>
<th>Post-partum</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>“Giving In” Total</td>
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<td>1.97</td>
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<tr>
<td>Fast Food Fats</td>
<td>2.48</td>
<td>0.76</td>
<td>2.28</td>
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