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Gestational Weight Gain Patterns

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GESTATIONAL WEIGHT GAIN PATTERNS

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Abstract

Background: Managing gestational weight gain (GWG) remains a global health priority as obesity among women of childbearing age and their children have been linked to excessive GWG. Excessive GWG has been linked to increased rates of cesarean sections, preterm births, hypertensive disorders, gestational diabetes, large for gestational age newborns, postpartum weight retention, long-term obesity for the woman and her children. Conversely, adverse outcomes resulting from weight gain below recommendation could potentially include preterm births, increased rates of neonatal intensive care admission, and newborn morbidity and mortality. Previous studies indicate the need for healthcare providers to help women gain within the recommended guidelines to decrease incidence of adverse outcomes.

Purpose: This study explores the concept of gestational weight, describes maternal characteristics of women who adhere to the recommended guidelines, examines correlates of socio-demographic, maternal and newborn characteristics, and gestational weight gain patterns, and identifies women staying within the Institute of Medicine's (IOM) 2009 recommended guidelines for GWG. To adequately address GWG patterns, study aims were achieved through concept analysis and retrospective data collection to: (1) identify GWG patterns among the sample by describing the characteristics of women who gained above, within, or below the IOM's recommended guidelines and (2) examine correlates of GWG patterns.

Methods: A descriptive, correlational, cross-sectional design using retrospective data abstracted from medical records was used. A purposive sample of all women (N = 4500) who gave birth between January 1, 2011 and December 31, 2012 at a large multi-community hospital healthcare system in San Diego County provided data for this study. Inclusion criteria: singleton live birth, data on pre pregnancy BMI & GWG, $\geq$ 4 prenatal visits, and delivered at $\geq$ 37 weeks gestation. Two hundred ninety women met inclusion criteria. Descriptive and inferential statistics were used to assess characteristics of the sample and examine relationships between the variables. **Results:** Manuscript #1 titled " *Understanding the Concept of Gestational Weight"* analyzes the concept of gestational weight and its contributing factors, clarifies its meaning, and addresses implications for practice and the need for future studies. Manuscript #2 titled " Mothers' Characteristics and Gestational Weight Gain Patterns" identifies adherence to GWG recommendations and examines the characteristics of women who gain within, below or above the 2009 IOM GWG guidelines. Manuscript #3 titled " Correlates of Gestational Weight Gain within the 2009 IOM Recommended Guidelines" examines the relationships between women's socio-demographic, maternal and newborn characteristics, and gestational weight gain patterns.

Implications: The results of this study show there is an increased need for healthcare providers to provide appropriate guidance and support to women of childbearing age. Providers should offer preconception counseling and surveillance to help women achieve normal pre-pregnancy BMI then continue to work with women during pregnancy to gain

weight within the recommended range to decrease incidence of adverse pregnancy outcomes for both women and their children.

Dedication

This book is dedicated to my family as they inspired me to realize my dream. My husband Wayne's I love you and thanks for the support and constant reminders letting me know I can do this and how proud he is of my accomplishments kept me going. You are my hero and best friend. I would like to thank my two wonderful children, Jamall and Monique, who are beautiful inside and out and have been my cheering team from the beginning. I am so proud of you and love you lots. To my sister Carol and brother Noel, I appreciate your phone calls and constant encouragements. To my momma and daddy, I know you are looking down and feeling proud of my accomplishments. To my extended family and dear friends, I will always remember your genuine support of me throughout this process. Lastly, I would like to thank my Uncle Linton who told me as a child that I could accomplish anything I put my mind to and encouraged me to aim high.

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CHAPTER I

INTRODUCTION

Maternal gestational weight gain (GWG) is a global health priority (Healthy People 2020, 2014). Extant research shows adverse pregnancy outcomes for both mother and child if a woman gains pregnancy weight over or under the Institute of Medicine's (IOM) recommended guidelines based upon pregnancy body mass index (BMI). Indeed, managing gestational weight remains a challenge for healthcare providers. Identifying risk factors and relationships to GWG outside and within the guidelines and pregnancy outcomes as they relate to maternal gestational weight has implications for women, children, families, and society.

The Centers for Disease Control and Prevention's (2007) Select Panel on Preconception Care released recommendations to improve the preconception care of women; one recommendation specifically addresses preconception weight. A gap exists, however, between recommendations and practice, acknowledged to be related in part to the fact 1 in 5 women of childbearing age are uninsured. Preventative care services for these women are usually provided episodically through federally funded family planning programs rather than traditional primary care settings, leading to lack of adequate surveillance and effective education about weight gain during pregnancy and its

impact on women and their unborn children (Johnson et al., 2006; March of Dimes Foundation, 2013; US Preventive Services Task Force, 2003).

Background and Significance

With the rates of adult and adolescent obesity increasing, the prevalence of obesity among women of childbearing age (15-44 years) is expected to increase (Zera, McGirre, & Oken, 2011). Alarmingly, nearly two-thirds of women of childbearing age in the United States have an overweight body mass index (BMI; > 25 kg/m^2), which puts them at risk for developing chronic medical conditions such as type 2 diabetes, hypertension (Rahman & Berenson, 2012), and related disabilities, which contributes to high medical expenses and creates a burden on the country's economy (Meng, Liebel, & Wamsley, 2011). Notably, the US spent $190 billion on obesity-related healthcare expenses in 2005 that doubled previous estimates (Cawley & Meyerhoefer, 2012). This places a burden on the already troubled economy and has thus gotten the attention of policymakers, who are working collaboratively to develop possible solutions.

Women of childbearing age are at increased risk of gaining excess weight during the perinatal period (Flegal, Carroll, Ogden, & Curtin 2010; Sarwer, Allison, Gibbons, Tuttman-Markowitz, & Nelson, 2006), which predisposes them to increased risk for pregnancy-related complications including preeclampsia, gestational diabetes, and increased rates of caesarean delivery. Reports indicate 27% of women of childbearing age fall into the obese category and 8% are in the BMI category of extreme obesity (≥40 kg/m^2 (Rasmussen & Yaktine, 2009). Previous studies have found a direct link to lifelong obesity for a woman who gains too much weight during pregnancy if she had an

overweight or obese pre-pregnancy BMI. There is also a link to childhood obesity and adverse fetal and maternal outcomes (Rasmussen, Catalano, & Yaktine, 2009).

Pregnancy outcomes linked to women with obese pre-pregnancy BMI include gestational diabetes, preeclampsia, preterm birth, difficult labor, increased caesarean birthrate, wound infection, thrombolytic disease, and postpartum weight retention (Bhattacharya, Campbell, Liston, & Bhattacharya, 2007; Stothard, Tennant, Bell, & Rankin, 2009). Previous GWG studies have documented associations between chronic illness, adverse pregnancy outcomes, and postpartum weight retention (Anderson, Ebrahim, Floyd & Atrash, 2006). Women whose weight gain exceeds the Institute of Medicine's (IOM) recommended GWG guidelines have greater chances of retaining extra pounds after birth and having babies larger than normal with extra fat that often require a cesarean delivery.

Women with overweight and obese pre-pregnancy BMI who gain excessive weight during pregnancy are more likely to have children who are or become overweight or obese. When gestational weight gain was examined using IOM guidelines, the chance of overweight was 48% greater for children of mothers who gained weight in excess of the guidelines than for children of mothers who met the weight gain guidelines (Catalano et al., 2009; Wrotniak, Shults, Butts, & Stettler, 2008; Walker, 2007). Children born to mothers who were obese at the time of pregnancy were two and a half times at risk for obesity at three to four years of age (Hillier, Pedula, Schmidt, Mullen, Charles, & Pettit, 2007; Walker, 2004). Indeed, extant studies found maternal pregravid obesity; BMI was the strongest perinatal predictor of childhood obesity, in contrast to maternal glucose hemostasis or weight gain during pregnancy (Catalano et al., 2009; Stothard et al., 2009).

Moreover, congenital anomalies that have been associated with maternal overweight and obesity are neural tube defect, cardiovascular, septal defects, cleft lip and palate, hydrocephaly, anorectal atresia, and short limb reduction (Stothard et al., 2009). Gaining too little weight or inadequate GWG is also a concern and may result in low-birth-weight babies or babies that are small for gestational age (SGA), intrauterine growth restriction, and preterm births with increased neonatal intensive care units (NICU) admissions, leading to higher incidence of neonatal morbidity and mortality (Han et al., 2011).

IOM Guidelines

The IOM Guidelines, published in 1960 and subsequently reviewed and revised in 1990 and 2009, were originally developed for women gaining inadequate weight during pregnancy that led to severe adverse fetal outcomes and increased infant mortality rates (Agency for Healthcare Research and Quality [AHRQ], 2008; IOM, 2009). A recent rigorous systematic review supported the 1990 recommendations with a modification to the target weight gain for obese women: the IOM now recommends these women remain in a weight gain range of 11-20 pounds, in contrast to up to 15 pounds recommended in the 1990 (IOM, 2009; Table 1).

The updated guidelines stem from growing evidence linking pre- and post-pregnancy weight gain to a number of health problems for both mother and baby. Approximately 70% of pregnant women fail to comply with the guidelines and studies indicate this is primarily due to the healthcare provider's lack of counseling on recommendations about appropriate GWG (Rasmussen et al., 2009; Stotland, Tsoh, & Gerbert, 2011).

Table 1

Comparison of 1990 and 2009 IOM GWG Guidelines

	1990 IOM Guidelines	2009 IOM Guidelines
Pre-pregnancy BMI cut-points		
Underweight	<19.8	<18.5
Normal weight	19.8-25.9	18.5-24.9
Overweight	26.0-29.0	25.0-29.9
Obese	>29.0	>30.0
Gestational weight gain recommended ranges		
Underweight	28-40 lb. (12.5-18 kg)	No change
Normal weight	25-35 lb. (11.5-16 kg)	No change
Overweight	15-25 lb. (7-11.5 kg)	No change
Obese	At least 15 lb. (7 kg)	11-20 lb. (5-9 kg)
Specific recommendations for adolescents (<18 years)	Pre-pregnancy BMI cut-points based on CDC BMI charts; weight gain in upper range of the recommended values	Pre-pregnancy BMI cut-points based on IOTF BMI categories with no difference in the amount of weight to be gained based on age
Specific recommendations for black women	Weight gain in upper range of the recommended values	None
Specific recommendations for women of short stature	Weight gain in lower range of the recommended values	None

Note: BMI = body mass index; CDC = Centers for Disease Control and Prevention; IOM = Institute of Medicine; IOTF = International Obesity Task Force.

Links to Healthy People 2020 Objectives

Healthcare providers are charged to address the Maternal Infant Child Health (MICH-13) Healthy People 2020 objective of increasing the proportion of mothers who achieve the recommended weight gain during their pregnancies (Healthy People 2020, 2014). It is clear that appropriate GWG patterns remain a challenge for healthcare

providers and women; further research is needed to examine women's GWG patterns, knowledge, attitudes, and barriers to following the 2009 IOM GWG Guidelines, and pregnancy outcomes. The IOM has placed an emphasis on improving patient outcomes and has charged healthcare providers and researchers with developing substantial interventions to decrease the prevalence of adverse outcomes linked to inappropriate GWG (Rasmussen et al., 2009). The IOM recommendation is in line with the new healthcare reform called the Affordable Care Act, which puts emphasis on improved health outcomes and calls for a change in healthcare delivery systems, requiring healthcare providers to focus on prevention and improved patient outcomes (Honoré & Scott, 2010). Despite the knowledge generated from previous research studies, managing gestational weight remains a challenge for healthcare providers (Gillman, 2012). Several studies have suggested one gestational weight gain recommendation is not appropriate for all women as it does not take into account cultural differences and body types (AHRQ, 2006; IOM, 2009). Further evidence is needed from racially, ethnically, and economically diverse populations to identify factors contributing to GWG problems, assess whether women are adhering to the recent 2009 IOM recommendations, and determine any barriers to adherence (Lovell, El Ansari, & Parker, 2010; Rasmussen et al., 2009).

Purpose, Aims, and Research Questions

The purpose of this study was to examine gestational weight gain patterns among a group of racially, ethnically, economically diverse women who were admitted to and gave birth at a large multi-hospital healthcare system in San Diego County between January 1, 2011 and December 31, 2012. Information gained from a retrospective chart

review provided insight into GWG patterns and whether women were receiving adequate advice about and following the 2009 IOM GWG guidelines.

The specific aims of this study were to:

1) Analyze the concept of gestational weight gain
2) Describe a sample of women who were admitted and gave birth at a large multi-hospital healthcare system in San Diego County between January 2011 and December 2012
3) Examine the characteristics of women whose weight gain was above, within, or below the 2009 IOM-recommended GWG guidelines based on pre-pregnancy BMI
4) Examine correlates of GWG patterns in women whose weight gain was within the 2009 IOM-recommended guidelines based on pre-pregnancy BMI

Specific characteristics explored included socio-demographic information (socioeconomic status [SES], medical insurance status, age, marital status, primary language, race/ethnicity), smoking, alcohol consumption, illicit drug use; clinical characteristics for the woman (parity, gestational age, pre-pregnant BMI, GWG, mode of delivery), health care provider, and GWG patterns among pregnant women. Clinical characteristics for the newborn were obtained to include Apgar scoring at 1 minute and 5 minutes, term or preterm, gestational age, and size. Other information obtained was Pitocin induction and augmentation, failed induction, the number of live births, postpartum complications (e.g., postpartum hemorrhage and postpartum infection) and their associations with GWG patterns.

This study addressed the following research questions:

1) What are the characteristics of women who gained above, within, below the 2009 IOM GWG guidelines based on pre-pregnancy BMI?
2) What were the correlates to GWG patterns in women who gained within the 2009 IOM GWG guidelines based on pre-pregnancy BMI?
3) What percentage of women adhered to the 2009 IOM GWG guidelines based on their pre-pregnancy BMI?
4) What were the relationships among the study variables and GWG patterns based on the 2009 IOM GWG guidelines?

Conceptual Framework

Conceptual frameworks provide researchers with the foundations to build their studies and enable a greater understanding of an issue, leading to better success of proposed interventions. These frameworks assist researchers with methodological choices made throughout the research process and offer a clear, consistent frame of reference for making those decisions (Polit & Beck, 2012). The conceptual framework is critical for researchers using quantitative, qualitative or mixed method designs, as it can help the researcher to show relationships visually as well as in narrative forms.

The conceptual framework used to inform this retrospective chart review study was the Pender Health Promotion Model (Figure 1).

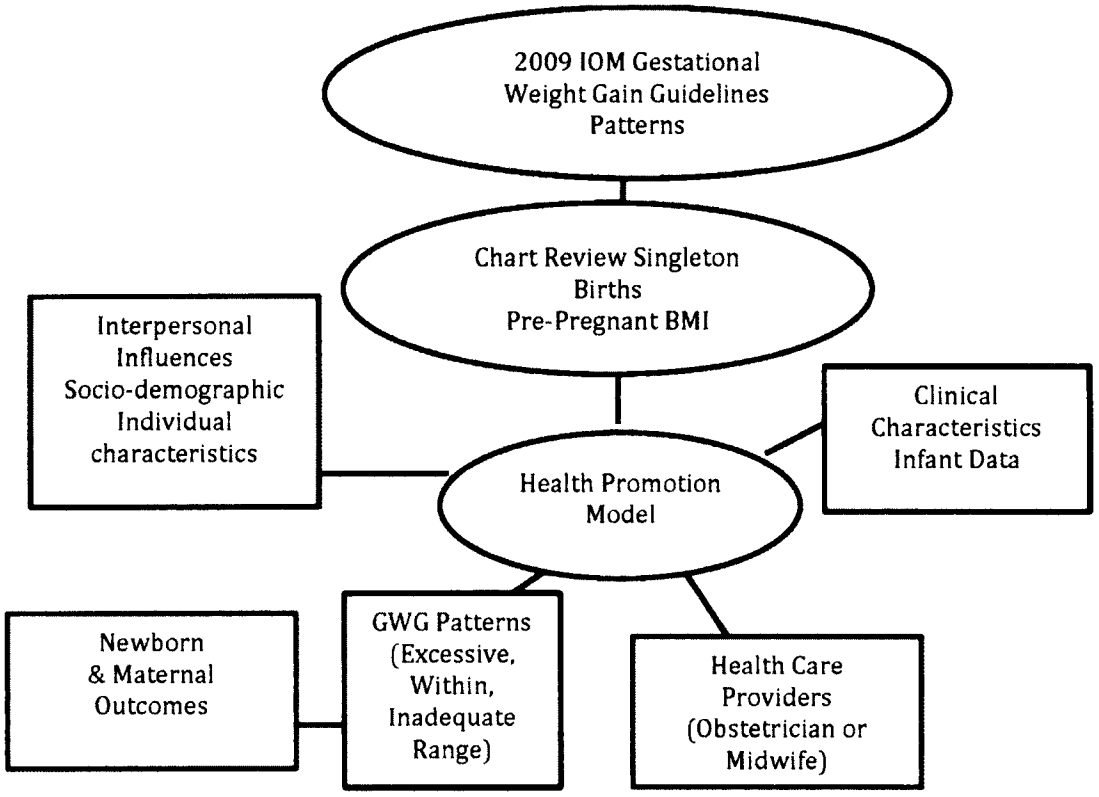

Figure 1. GWG patterns conceptual framework.

Pender Health Promotion Model

The health promotion model was first introduced in 1982 by Nola Pender then revised in 1996 based on changing theoretical perspectives and empirical findings (Pender, Murdaugh, & Pearsons, 2011). The model informed this study by helping the researcher to understand the major determinants of health behaviors as a basis for behavioral counseling to promote healthy lifestyles (Pender, 1996). Using parts of the health promotion model to inform this study yielded information healthcare providers can use to assist clients in changing behaviors to achieve a healthy lifestyle. The specific model elements utilized are Individual Characteristics and Experiences such as Personal Factors (pre-pregnancy BMI, GWG, age, race/ethnicity, socioeconomic status, and parity). Interpersonal influences are: specific providers (private medical doctors

[MDs]/obstetricians, certified nurse midwives [CNM]), and private and government-funded medical insurances. This research studied variables that can predict as well as show correlations to potential outcomes relating to GWG patterns. The nurse researcher assessed the data on some of the relevant factors of this model by using a quantitative design approach through retrospective chart review.

The results from this study can be used to custom design a health promotion program for women of childbearing age in effort to improve GWG. Results of this study can also help healthcare providers devise methods of producing behavioral changes to improve outcomes for women and children, as this model identifies foci to develop future nursing interventions for health promotion to include exercise, nutrition, stress management, and social support (Pender et al., 2011). Pender's positive views of health permit the development of nursing interventions that are not limited to decreasing risks for disease but are aimed at strengthening resources, potentials, and capabilities. This creates broader opportunities for nurses to assist individuals and communities to achieve improved health, enhanced functional ability, and better quality of life (Peterson & Bredow, 2009).

Women of childbearing age or women who have experienced prior pregnancies are more likely to have highly perceived competence or self-efficacy in certain behaviors that could result in greater likelihood they will commit to action and actually perform positive behaviors that improve health outcomes (Pender et al., 2011). Use of the health promotion model to identify predictors leading to inappropriate GWG resulting in adverse pregnancy outcomes will help healthcare providers and women of childbearing age commit to an action plan to attain high-level wellness and self-actualization for these

women. Extant studies show researchers' selective use of the health promotion model to determine what model concepts to include in their study designs based on the particular area of research need (Peterson & Bredow, 2009).

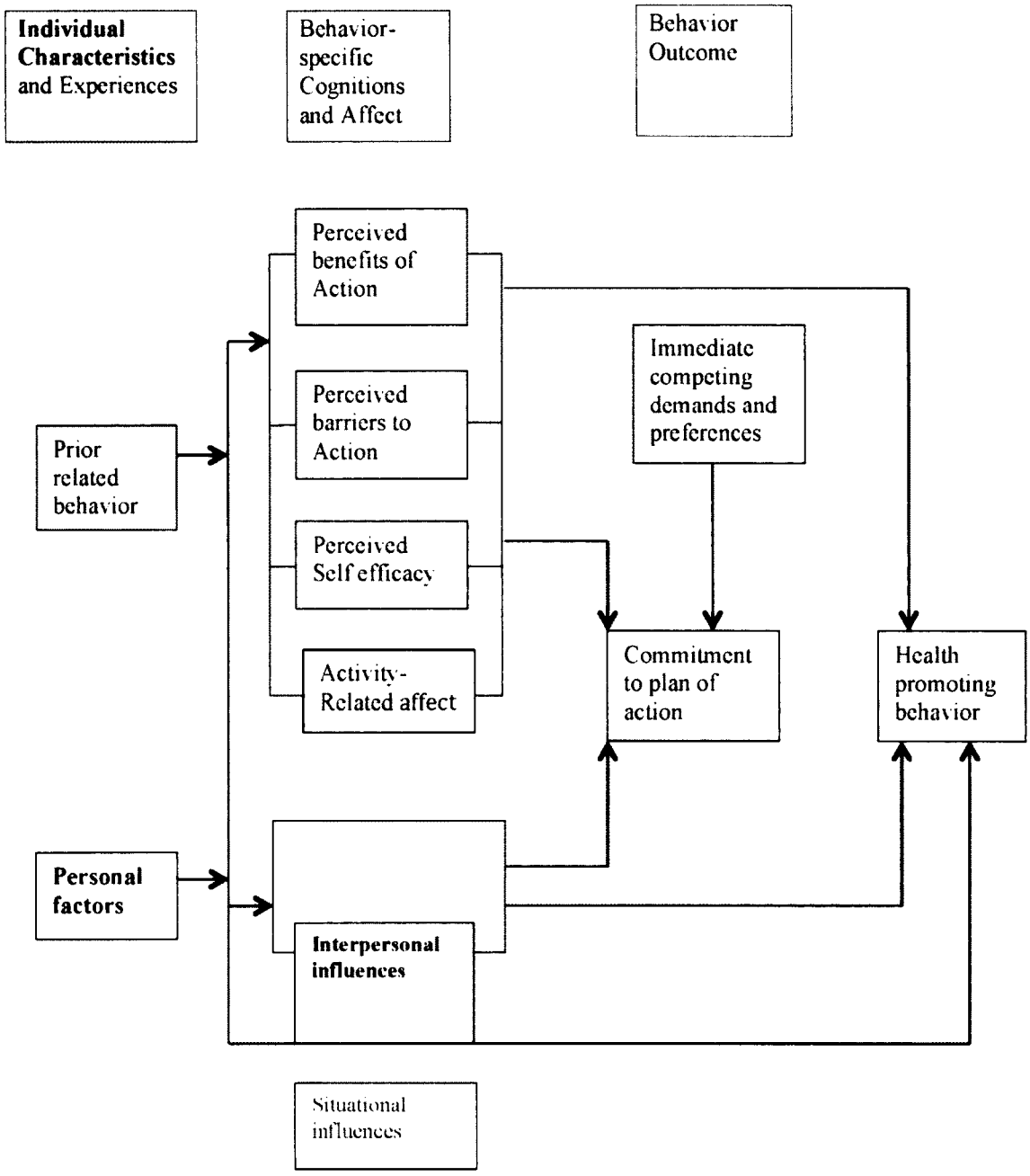

Figure 2. Revised Pender health promotion model.

Implications for Nursing

It is important for nurses to study factors associated with inappropriate GWG patterns based on pre-pregnancy BMI and identify any predictors or adverse pregnancy outcomes. Additionally, if there continues to be a lack of adherence to the 2009 IOM GWG recommendations with its accompanying sequela, obesity among women and children will continue to escalate, leading to devastating health effects and increased healthcare costs. Knowledge gaps need to be filled to inform and ultimately improve clinical care. Findings from this study will add to the knowledge base to inform healthcare providers of potential risk factors and outcomes associated with weight gain among pregnant women and assist in the development and implementation of effective interventional programs to minimize this issue.

Understanding the determinants of gestational or pregnancy weight gain is essential for designing clinical and public health interventions to prevent overweight and obesity in mothers and children. These interventions should be guided by a conceptual understanding of predictors of excessive gestational weight gain to aid in interpreting effects, thereby translating findings into effective practices.

CHAPTER II

LITERATURE REVIEW

The purpose of this study was to examine gestational weight gain (GWG) patterns among a group of racially, ethnically, economically diverse women, admitted and giving birth between January 2011 and December 2012 at a large multi-hospital healthcare system in San Diego County. Information gained from a retrospective chart review provided insight into GWG patterns and variables that correlate to GWG patterns based on pre-pregnancy body mass index (BMI) were identified.

An extensive review of the literature found more research was needed to 1) examine adherence to GWG guidelines based on pre-pregnancy BMI and 2) how this correlates to predictors and outcomes of GWG patterns. This chapter presents a discussion of weight (underweight, normal, overweight, and obesity) among women of childbearing age, GWG patterns with known predictors and related outcomes, pre-pregnant BMI role in GWG patterns, and other potential covariates. Potential covariates by domain include socio-demographic characteristics (age, marital status, primary language, race/ethnicity), socioeconomic status (SES; indicated by medical insurance status), smoking, alcohol consumption, illicit drug use, clinical characteristics (parity, gestational age, pre-pregnant BMI, vaginal or caesarean section, Pitocin induction and

augmentation, failed induction, live births, stillbirths, and postpartum complications), infant data (infant gestational size, Apgar scoring, preterm or term), and provider (obstetrician or midwife).

Recent studies suggest the use of monitoring maternal BMI gains before and during pregnancy play an important role in assessing obstetric outcomes (Olson, 2008; Ochsenbein-Kolble, Roos, Gasser, & Zimmermann, 2007). Among medical communities there is an increased international consensus that obesity is a serious health concern; at least one in three of the world's adult population is overweight and almost one in 10 is obese. Obesity is strongly associated with life-threating and debilitating conditions such as type 2 diabetes, coronary artery disease, certain types of cancers, female infertility, pregnancy complications, and back pain (WHO, 2000; 2004; 2013). Changes in eating patterns and increasing sedentary lifestyles are known to be contributors of obesity over genetic determinants of obesity based on extant studies. Consequently, lifestyle modifications and health promotion should be targeted through health education about the risks associated with obesity.

Gestational Weight Gain and Pregnancy

Takimoto et al. (2011) conducted a study with 1,617 women from three obstetrical departments located in 3 Japanese settings: urban, suburban, and rural. Findings indicated women who delivered at urban and suburban settings were 30 years and older, were more likely to deliver via caesarean, and gained less weight than women in the rural setting. Women who delivered in the rural setting were younger and more likely to be underweight. The prevalence of pregnancy-induced hypertension (PIH) and diabetes was significantly higher and the prevalence of premature labor was significantly

lower in the suburban setting when compared to rural and urban settings. Prevalence of threatened abortion was significantly lower in rural setting compared to the other two settings. Gestational length was slightly longer in the urban setting compared to rural setting. Very few infants were macrosomic (birth weight 4000g or greater) or large for gestational age (LGA) in all three settings. Infants born to primiparas were more likely to be LGA than those born to multiparas (5.0% vs 2.6%, $p = 0.001$).

In the study mentioned above, maternal weight gain was calculated by subtracting self-reported pre-pregnancy weight from measured weight at delivery. This showed self-reported pre-pregnancy weight was considered appropriate for use in this study. There were no significant differences in the number of LGA among the three settings. Women who were underweight before pregnancy had a significantly lower odds ratio (OR) (0.30, 95%Cl 0.11-085) for LGA compared to normal weight women, and overweight women had a significantly higher OR (2.73, 95%Cl 1.42-5.28. Primiparas had significantly higher OR (2.20, 95%Cl 1.28-3.77 for LGA compared to multiparas. Women who gained less than 0.11 BMI per week and women who gained more than 0.13 per week were more likely to have LGA infants (OR: 2.22, 95%Cl 1.13-4.38). Weight and BMI gains between 26-28 weeks and 32-34 weeks were unrelated to LGA. Caesarean delivery rates were significantly higher in the urban setting compared to the rural setting. Primiparas had significantly higher OR for cesarean OR compared to multiparas. Maternal smoking, anemia, PIH, diabetes, and premature labor were not related to increased caesarean rates but a history of threatened abortion significantly increased the risk (OR: 2.36, 95%Cl 1.12-4.94).

Overweight and Obesity Among Women of Childbearing Age

The prevalence of overweight and obesity in the United States has increased dramatically over the past 20 years; recent students have shown there are 62% of women who could become pregnant are overweight (BMI greater than 25 kg/m^2 ; (Flegal, Carroll, Ogden, & Curtis 2010; Ogden, Carroll, Curtin, McDowel, Tabak, & Flegal, 2006). One in 5 women are obese when they conceive (Zera, McGirr, & Oken, 2011). Women are at risk for complications of untreated obesity particularly during the reproductive years and may benefit from targeted screenings (Godfrey & Nachtigall, 2009).

The 2003-2008 National Health and Nutrition Examination Survey (NHNES) found 98% of women who correctly perceived themselves as overweight desired to weigh less, and 72% were actively attempting to lose weight compared with only 37% of women who do not perceive themselves as overweight. Moreover, overweight and obese women who received a diagnosis of overweight or obesity from their healthcare provider were twice as likely to endorse weight control behaviors such as diet and exercise as women who did not have a formal diagnosis. The potential benefits of obesity screening as part of preconception counseling remain unexplored (Yaemsiri, Slining, & Agarwal, 2010).

Several cohort studies have assessed pre-pregnancy physical activity by examining the association of physical activity prior to pregnancy with health behaviors and outcomes during and after pregnancy (Chasen-Taber, Schmidt, Pekow, Sternfeld, Solomon & Markenson, 2008; Chuang, et al, 2009; Hinton & Olson, 2001; Pereira, Rifas-Shiman, Kleinman, Rich-Edwards, Pererson, & Gillman, 2007; Zhang, Solomon, Manson, & Hu, 2006). Regular physical activity is recommended for all women of

reproductive age because physical activity is associated with reduced risk of disease, maintenance of healthy weight, and promotion of optimal preconception health.

The American Dietetic Association and the American Society for Nutrition issued a joint statement supporting counseling all overweight and obese women of reproductive age on dietary modification and physical activity (Siega-Riz & King, 2009). In a cross-sectional study using data from the CDC and Prevention's Pregnancy Risk Assessment Monitoring System (PPRAMS) assessing the prevalence of self-reported pre-pregnancy physical activity among 4,069 women who delivered live birth in 2004 in Maine, North Carolina, and Washington State, most women in the months preceding their pregnancy do not meet the national recommendations for physical activity (Donahue, Zimmerman, Starr, & Holt, 2010). The prevalence of inactivity reported in this study was similar to the prevalence estimates for women using data from the National Health Interview Survey (Schoenborn, Adams, Barnes, Vickerie, & Schiller, 2004).

Declines in physical activity levels during pregnancy appear common and most women do not return to their pre-pregnancy physical activity levels during the postpartum period (Pereira et al., 2007). Physical inactivity can lead to increased risk of pregnancy complications and postpartum weight retention. Moreover, the data collected in the study by Donahue et al. (2010) found lower educational level and history of live births were strong independent predictors of physical activity prior to pregnancy, consistent with other studies examining these characteristics. Conversely, moderate to vigorous physical activity was observed among women between the ages of 18-30 who participated in the Third National Health and Nutrition Examination Survey (NHANES; Dowda, Ainsworth,

Addy, Saunders, & Riner, 2003). Family responsibilities and caregiving duties serve as barriers to physical activities as reported by some women (Eyler et al., 2002).

In 1999-2002, 62% of women in the U.S. over 20 years of age were overweight, (defined as having a BMI greater than 25 kg/m^2), one-third were obese (having a BMI of over 30 kg/m^2), and 15% aged 12-19 were overweight (Hedley, Ogden, Johnson, Carroll, Curtin, & Flegal, 2004). Obesity is associated with chronic medical conditions such as diabetes, hypertension, cardiovascular disease, and osteoarthritis and with pathologies of the reproductive track including irregular menses, infertility, preeclampsia, and gestational diabetes (Nuthalapaty, Rouse, & Owen, 2004). Therefore, obesity during pregnancy is common and increases obstetrical risks.

Effects of Overweight and Obesity on Pregnancy

In 2006, there were over 4.3 million live births in the United States (Martin et al, 2006). Due to the increasing rates of overweight and obesity in women of childbearing age exceeding 60%, greater than 2 million infants were at risk to be born to an overweight and obese mother in 2003. As a result of these staggering statistics, questions were raised about the long-term effects and what healthcare providers and policymakers are doing to address this dilemma (Sarwer, Allison, Gibbons, Tuttman-Markowitz, & Nelson, 2006).

Obesity is an epidemic in most developed countries and it is essential that education-based health promotion strategies be presented in a culturally competent manner regarding the effects of obesity on health (Tsai et al., 2004). In a study evaluating the application of the Obesity Risk Knowledge (ORK) 10 scale, it was concluded that obesity-related health risk knowledge was shown to predict weight control behavior.

Furthermore, the ORK scale suggested public health campaigns might be effective in reducing rates of obesity in the same way that the provision of health risk messages has been successful in reducing the rates of smoking (Swift, Glazebrook, & Macdonald, 2006).

The relationship between obesity and fertility problems has been demonstrated in many studies (Catalano, 2007; Shah & Ginsburg, 2010). Excessive adipose tissue on neuroendocrine functioning, including insulin resistance, hyperinsulinemia, and hyperandrogenism, is believed to negatively affect fertility. Polycystic ovarian syndrome (PCOS) is a common form of fertility difficulties in obese women (Salehi, Bravo-Vera, Sheikh, Gouller, & Poretsky, 2004; Van de Merwe, 2009).

Obesity and BMI have been independently associated with an increased risk of a number of pregnancy complications, including preeclampsia, gestational diabetes, infections, congenital malformations such as neural tube defect, heart defect, anorectal atresia, hypospadias, limb reduction defects, diaphragmatic hernia, omphalocele, and oral clefts, preterm labor and delivery, cesarean sections, and high maternal and infant morbidity rates (Brown & Avery, 2012; Cedergren, 2004; Galtier, Raingeard, Renard, Boulot, & Bringer, 2008; Rasmussen, Chu, Kim, Schmid & Lau, 2008;). Obesity is also linked to miscarriages. In a study of 24,505 single pregnancies in Denmark, obesity was associated with a significantly greater risk of stillbirth and neonatal death compared with normal weight (Kristensen, Vestergaard, Wisborg, Kesmodel, & Secher, 2005).

Historical Look at Preconception Counseling and GWG

During the past 50 years, recommendations for pregnancy weight gain have been controversial in the US. Obstetricians placed a value on how much weight a woman

should gain during pregnancy in an effort to curtail excessive weight gain, recommending women gain no more than 26 pounds (12.5 kg) and preferably 15 pounds (6.8 kg). Early in the 20th century, obstetricians restricted weight gain during pregnancy to prevent toxemia (preeclampsia), difficult births, and maternal obesity. In 1966, the severe weight restriction was challenged when obstetricians began to recognize the high rates of infant mortality, disability, and mental impairments seen in the US as a result of low birth weight. This eventually led the National Academy of Sciences Committee on Maternal Nutrition to increase the recommendation for pregnancy weight gain to 9-11.4 kg (19.8 - 25.8 lbs (National Research Council, 1970), leading to increases in pregnancy weight gain and infant birth weights. Women started to gain an average of 9-12 kg (19.8 - 26 lbs) and in some instances 14 kg (30.8 lbs). The scientific literature started to address the relationships between pregnancy weight gain and certain maternal and fetal outcomes.

IOM 1990 and 2009 GWG Recommendations

By 1985, the concept of preconception care and its potential advantages began to gain momentum. In that year, the IOM published *Preventing Low Birthweight* and recognized there were ample opportunities to reduce the incidence of low birth weight, but these were often overlooked and more were in favor of interventions during pregnancy rather than preconception counseling risks (IOM, 1985). The IOM committee emphasized the importance of pre-pregnancy risk identification and to provide health education related to pregnancy outcomes. Suggestions were made for family planning agencies to address concepts of pre-pregnancy wellness and identify risks associated with poor pregnancy outcomes.

In 1989 the US Expert Panel on the Content of Prenatal Care strongly recommended preconception counseling in the context of its effect on pregnancy be included as part of the office visit and called for medical insurance reimbursement (USPHSEPPC, 1989). At this time, the National Academy of Sciences started to reexamine the woman's nutrition and GWG adverse effects of excessive weight gain due to the liberal recommendations of GWG. A report published in 1990 supported the strong association between pregnancy weight gain and infant size and provided recommended weight gain guidelines for pregnancy based on pre-pregnancy BMI (IOM, 1990).

In the years since the 1990 IOM recommendations, a large body of literature accrued, addressing not only birth weight but also outcomes related to labor, delivery, and maternal postpartum weight gain status. Some studies showed the average gestational weight gain in some settings continued to increase. In 1995, Johnson and Yancey critiqued the 1990 IOM guidelines arguing they were unlikely to improve perinatal outcomes and would lead to negative effects for women and children. This was echoed by Feig and Naylor (1998), who believed the recommendations would cause more harm than good and feared they would lead to large babies with an increased risk of cesarean deliveries and obese mothers. Notably, studies have shown weight gain below the IOM guidelines are associated with many poor pregnancy outcomes than are weight gains within the ranges (Rasmussen & Yaktine, 2009).

According to the American College of Obstetricians and Gynecologists (ACOG), components of preconception care should include addressing excess weight gain because it significantly increases the likelihood of prematurity and NICU admissions (Aly et al.,

2010). When discussing routine care as well as specific preconception care, addressing the relationship between maternal obesity and perinatal outcomes is necessary.

The IOM re-established gestational weight gain recommendations in 2009 for women with normal, low, and high pre-pregnancy BMI that became the standard guidelines for obstetric practice. The IOM argued there were shortcomings in knowledge of GWG and its impact on women and children that indicated the need for a revision (IOM, 2009). The IOM charged a committee to reexamine the 1990 guidelines for weight gain during pregnancy and determine whether there needed to be a revision based on increased rates of overweight and obesity along with studies revealing adverse pregnancy outcomes related to GWG patterns. The committee approached this challenge from the perspective of factors that affect preconception and the first year after delivery for both women and children. A key difference of the new guideline is that 2009 BMIs were based on WHO BMI categories, whereas the 1990 BMIs were adopted from the Metropolitan Life Insurance tables. Secondly, the 2009 guidelines included a narrow range for obese women, as ranges are known to produce more positive achievable outcomes within those recommended ranges accounting for age, race/ethnicity, or other factors that may affect pregnancy outcomes (IOM, 2009).

To meet these range recommendations, women will need preconception counseling and the first step is to let these women know about the guidelines and provide individualized attention. Special attention and counseling should be given to low-income and minority groups. The 2009 recommendations added obese pre-pregnant BMI ranges, but do not break them into obesity classes as more studies are needed to identify if there

is a need for specific recommendations based on the varying classes of obesity (IOM, 2009).

Effects of GWG on the Woman and Offspring

The 1990 IOM recommendations were criticized for being too liberal and for failing to consider the potential adverse effects of excessive weight gain during pregnancy. More recently, both the ACOG and the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) endorsed the recommended gestational weight guidelines based on pre-pregnancy BMI. Unfortunately, no specific recommendations were provided for women with extreme obesity (BMI $\geq$ 40 kg/m^2). Although these recommendations are a likely response to the obesity epidemic, it is not known if expectant mothers are aware of them or if practitioners routinely use these guidelines for clinical practice (Catalano, 2007).

A study conducted at the University of California, San Francisco assessed birth outcomes based on the 1990 IOM recommended weight gain ranges in 7,000 women who delivered at term. After other risk factors were adjusted for, GWG below the IOM recommendations were statistically significant with increased risk of delivering a small-for-gestational-age infant. GWG above was associated with an almost a double risk of delivering a large-for-gestational-age infant along with increased cesarean delivery; better outcomes were seen when women gained within the IOM recommended ranges (Parker & Abrams, 1992).

Weight gain above the IOM recommendations fosters adverse pregnancy outcomes, long-term weight retention, and children becoming overweight. Failure to lose pregnancy weight by six months postpartum results in more weight retention over the

long term (Rooney & Schauberger, 2002). The risks of adverse pregnancy outcomes increase as maternal BMI increases beyond the normal range (BMI $\geq$ 25 kg/m^2). Achieving pregnancy can be more difficult for obese women because they are less likely to ovulate regularly, have decreased fecundity, and have increased risk of miscarriage (Catalano, 2007).

Gestational diabetes affects about 20% of pregnancies in women who are obese and increases fourfold when compared to women with normal BMI. Additionally, hypertension during pregnancy is increased and these women have two- to threefold increase of preeclampsia (Weiss, Malone, Emig, Ball, Nyberg, & Comstock et al., 2004).

Once a woman is pregnant, both maternal and fetal risks are increased if high maternal BMI exists. Pregnancy-associated morbidity and mortality are higher in obese women than in normal-weight women (Goffman, Madden, Harrison, Merkatz, & Chazotte, 2007). High maternal BMI is associated with intrapartum complications such as increased rates of induction of labor and cesarean rates both for primary and repeat cesarean section deliveries (Chua, Kim, Schmid, Dietz, Callaghan & Lau, 2007). Other complications faced by pre-pregnant obese women during pregnancy include greater chances of infection, need for blood transfusion, venous thromboembolism, increased rates of maternal death, and near-miss morbidity (Goffman et al., 2007).

There is evidence to suggest excessive weight gain during pregnancy is a major contributor to adverse outcomes for both mothers and children. In a study conducted by Chua et al. (2008), after adjusting for age, race, or ethnic group, educational level, and parity, the mean length of hospital stay for delivery of a child was significantly greater among women who were overweight, obese, and very obese than women who had

normal BMI of 18.5-24.9 kg/m^2, averaging a longer stay of more than one day over the normal BMI women. Most of the increases in length of stay were related to increased rates of cesarean section deliveries and obesity related complications.

The frequencies of fetal tests, obstetrical ultrasound examinations, prenatal visits with physicians, outpatient medications, and telephone call to obstetricians were significantly greater for obese, very obese, and extremely obese women than for pregnant women with normal BMI. The presence of high-risk conditions during pregnancy increases the overall use of health care services and costs. Moreover, obesity during pregnancy is now a common high-risk obstetrical condition affecting about one in five women who give birth (Kim et al., 2007).

Besides GWG, maternal lifestyle is important to achieve healthy pregnancy outcomes. Pregnant women consuming ≥ 3 servings of fruit and vegetables per day gained 0.8 kg less than those who consumed fewer servings (Olson & Strawdermn, 2003). The "fetal origin hypothesis" by Barker 20 years ago postulates fetal undernutrition in middle and late gestation leads to disproportionate fetal growth and programs the fetus for the development of chronic diseases in adulthood (de Boo & Harding, 2006).

At least 40% of pregnant women gain above the recommended IOM range (Groth & Kearney, 2009). With the increased concern about the prevalence of obesity in reproductive-age women, the 2009 IOM guidelines now address recommended pregnancy weight gain using a stringent range (11-20 pounds total weight gain) for pre-pregnancy BMI in the obese category as compared to the 1990 recommendations (about 15 pounds (IOM, 2009).

A retrospective cohort study of 7,962 pregnant women in Germany were analyzed using the IOM 2009 recommendations/National Research Council (IOM/NRC) to assess whether and to what extent GWG below or above recommended trimester-specific cutoffs predict inadequate or excessive GWG at the end of the pregnancy. The study found on the basis of second-trimester-specific guidelines, inadequate GWG can be predicted in underweight and normal weight women, whereas excessive GWG can be predicted in overweight and obese mothers. Therefore, it appears possible to identify women at risk of gaining outside of the recommended guidelines as early as the second trimester (Chmitorz, von Kries, Rasmussen, Nehrng, & Ensenauer, 2012).

Rees et al. (2011) conducted a study in the United Kingdom to examine the extent of compliance with the recommendations to document height, weight, and BMI in the pregnant woman's chart. The audit revealed only 9% of pregnant women's charts showed documentation of BMI. This lack of documentation could lead to high-risk women being overlooked and potentially not referred to appropriate care and counseling.

As previously discussed, gestational weight gain is an indicator of increased birth weight; specifically macrosomia (birth weight over 4,000 grams), and overweight during infancy and childhood (Dietz et al., 2009; Frederick et al., 2008; Oken et al., 2009). Risks to children of obese mothers with excessive GWG include higher rates of congenital anomalies, low Apgar scoring, abnormal uterine growth, certain chronic metabolic diseases, and childhood obesity (Barker, 1995; Zera et al., 2011). Even normal birth weight children of obese mothers are more likely to be obese than children of normal weight mothers (Oken & Gillman, 2003). Other studies found low GWG was advantageous for the mother, but increased the risk of having a small-for-gestational-age

baby, particularly in underweight women, and low GWG is further associated with preterm births (Nohr et al., 2008; Stotland et al., 2006). These studies are based upon earlier IOM recommendations, studies are needed to assess GWG patterns using the 2009 IOM recommended ranges to include underweight, normal weight, overweight, and obese women.

Sociodemographic Data and GWG

Although the disparity in obesity by socioeconomic status (SES) has decreased over the past 3 decades, ethnic and racial disparity persists (Zhang & Wang, 2004). Sarwer, Allison, Gibbons, Tuttman-Markowitz, and Nelson (2006) reported rates of overweight and obesity among women of childbearing age differ by ethnic groups. For example, 49% of non-Hispanic White women and 70% of non-Hispanic Black women between 20-39 years old were overweight or obese (Sarwer et al., 2006).

Vahratian (2009) conducted a study to estimate the prevalence of overweight and obesity among US women of childbearing age using the 2002 National Survey of Family Growth (NSFG). This is an underutilized, nationally representative survey of individuals in the US (N = 12,571) and included 5,958 non-pregnant women aged 20-44 years with a valid BMI. Overall, 24.5% were overweight, and 23% were obese. Among the obese women, 10.3% met the criteria for class II or III obesity, which is BMI $\geq$ 35.0 kg/m^2. Non-Hispanic Black women were 2.25 times more likely to be overweight or obese compared to non-Hispanic White women. After adjusting for education, household income, and health insurance coverage, the disparity diminished and there were no statistically significant differences (Vahratian, 2009).

A study assessing the validity of classifying overweight and obesity based on self –reported weight in a representative sample of Hispanic women compared to other American populations was conducted by Gillum and Sempos (2005). This study found the under-estimation of the prevalence of overweight and obesity, based on height and weight self-reported at the interview, varied significantly among ethnic groups independent of other variables such as cigarette smoking, health status, and socio-demographic. Sivalingam et al. (2011) examined the awareness of obesity and accompanying health risks among US White, Hispanic, and African-American populations. Of the 1,031 participants, 48% were obese, and Whites were more likely to self-report obesity than minorities. Ethnic differences in obesity recognition disappeared when BMI was > 35 kg/m^2. African Americans (77%) were less likely to view obesity as a health problem contributing to hypertension, diabetes, and heart disease than Hispanics (88%); Whites (90%) were more likely to view themselves as obese. Of those who identified themselves as obese, 99% wanted to lose weight, but only 60% received weight loss advice from their healthcare provider. The authors concluded African Americans and Hispanics are significantly less likely to self-report obesity and associated health risks, highlighting the need for educational efforts for individuals with BMIs between 30 and 35.

The National Health and Nutrition Examination Survey (NHANES) is used to highlight the disparity in risk by race and ethnicity. However, it is unclear whether these rates are influenced by differences in socioeconomic status. A large proportion of pregnant women of differing ages with high pre-pregnancy BMIs among diverse

racial/ethnic groups gain more weight than is needed during pregnancy (Groth, 2008; Schieve, Cogswell, & Scanlon, 1998).

Due to a variety of environmental, socioeconomic, educational barriers, low-income urban women are at higher risk for excessive GWG, with the highest rates reported by Latina and African American women (Krummel, 2007; Rich-Edwards, Kleinman, Abrams et al., 2006; Setse et al., 2008). In a study conducted by Wright et al. 2013) based on the Theory of Planned Behavior, high-risk low income women were assessed on barriers to healthy eating, perinatal depression, nutrition knowledge, pregnancy intention status, weight locus of control, and self-efficacy for healthy eating during pregnancy with the intention of managing behaviors related to pregnancy weight. Over one-third (36.1%) of the women self-reported normal pre-pregnancy BMI while 32% were overweight, 26.7 % obese, and 31% were classified as gaining excessive weight during pregnancy. Women who had overweight pre-pregnancy BMI (44%) gained excessive weight compared to 24% who gained adequate GWG. Perinatal depression was associated with increased GWG using a univariate regression model, but after multivariate adjustment with age, race, pre-pregnant BMI, and other constructs, this was no longer significant. Barriers to healthy eating, nutrition knowledge, and categorical pregnancy intention status were not statistically significantly associated with GWG. One of this study's limitation is the reliance on self-report for pre-pregnant BMI and GWG. Women tend to underreport baseline weight and GWG especially if they gained excessive GWG. Therefore using data from retrospective chart reviews may provide a more accurate representation of pre-pregnant BMI and GWG.

Interventional Studies

Skoueris, Hartley-Clark, McCabe, Milgrom, Kent, Herring, and Gale (2010), conducted a systematic review of 10 interventional studies to identify and evaluate the effects of the key variables designed to modify risk factors for excessive weight gain in pregnant women that have been targets in interventions over the last decade. The findings were inconsistent in what factors needed to be targeted in intervention programs to reduce GWG. Consideration of psychological factors relevant to pregnancy, in addition to behavioral changes in relation to eating and physical activity are suggested for future interventional studies, as the10 studies mainly focused on physical activity and/or eating, The goal to reduce inappropriate GWG issues showed limited success in the 10 studies reviewed (Skoueris, Hartley-Clark, McCabe, Milgrom, Kent, Herring, & Gale, 2010; Walker, 2007).

Guelinckx, Devlieger, Mullie, and Vansant (2010) conducted a randomized controlled trial in Belgium to examine if a lifestyle intervention could improve dietary habits, increase physical activity, and reduce GWG in obese pregnant women. Participants were randomized to one of three groups: 1) the passive group received an intervention based on a brochure, 2) the active group received active education with the brochure and continued guidance from the nutritionist, and 3) the control group received nothing. The only difference between groups was that fat intake—specifically saturated fat—decreased and protein intake increased from the first to the third trimester in the passive and active groups compared with the control group. No significant differences in GWG, obstetrical, or neonatal outcomes were observed between groups.

Another randomized trial of a behavioral intervention to prevent excessive GWG tested a low-intensity behavioral intervention (face-to-face visit, weekly mailed materials that promoted an appropriate weight gain, healthy eating, exercise, individual graph of weight gain, and telephone-based feedback) during pregnancy to reduce postpartum weight retention in normal weight, overweight, and obese women (Phelan et al., 2011). Compared to the standard care group (n=200), the intervention group (n = 201) showed a decrease in the percentage of normal weight exceeded the IOM recommendations; 40.2% compared with 50.1% of the standard group. The study also found 30.7% of the intervention group women of normal weight, overweight, and obese returned to pregravid weights or below by 6 months postpartum when compared to only 18.7% of the non-intervention group.

Women's Perception of GWG

Excessive weight gain during pregnancy is a major determinant of high postpartum weight retention and long-term obesity in woman (Amorim, Rossner, Neovius, Lourenco, & Linne, 2007; Linne, Dye, Barkeling, & Rossner, 2004; Mamun, Kinarivala, O'Callaghan, Williams, Najman, & Callaway, 2010; Rooney, Schauberger, & Mathiason, 2005; Stotland et al., 2006) and is linked to several adverse maternal and fetal outcomes including gestational hypertension, diabetes, preeclampsia, and cesarean delivery in the mother, macrosomia, and long term obesity in their children (Margerison-Zilko, Rehkopf, & Abrams, 2010; Oken et al., 2008). Increased gestational weight gain is the strongest determinant of maternal postpartum weight retention and long-term weight gain with obesity independent of age (Amorim et al., 2007; Groth, 2008; IOM, 2009; Oken, Kleinman, Belfort, Hammitt, & Gilman, 2009).

Some women restrict their pregnancy weight gain by dieting and become distressed about their pregnancy-related weight gain. Conversely, women who consider body changes to be a positive result of being pregnant have a more favorable attitude about their weight gain and gained more weight than the women who experience negative feelings about their weight gain (Dipietro, Miler, Costigan, Gurewitsch, & Caulfield, 2003). Stotland et al. (2005) found women with higher BMIs had higher pregnancy target weight gains than women who weighed less. Pre-pregnancy BMI was the strongest predictor of target weight gain. In this study, it was noted overweight and underweight women were more likely than normal weight or obese women to receive incorrect weight gain advice during pregnancy.

In a mixed method study using content analysis techniques developed by Groth and Kearney (2009), interviews were conducted in a pediatric waiting room in an urban northeastern clinic to elicit ethnically diverse, low-income new mothers' thoughts about pre-pregnancy weight, gestational weight gain, and post-pregnancy weight. Approximately two thirds (66%) of the women reported they thought about GWG but were more concerned about being overweight after pregnancy. Women felt weight gain was good for the baby, benefitted the baby, and was not about them. A few expressed they did not think about GWG or kept track because it was the only time they can eat what they want. Still some of the women felt gaining less than the prescribed amount would not pose a problem and a few believed it would be easier to lose weight after pregnancy. Most White women in the study compared to Hispanic and Black women were more accurate in reporting weight gain that fell within the IOM recommendations. Black women reported less weight gain than the recommended range for normal weight.

The women were split on whether pre-pregnancy weight was related to how much weight they should gain during pregnancy. Black women more often than White or Hispanic women thought pre-pregnancy weight had little or no effect on GWG recommendations. One-third of the participants believed gaining over the IOM recommendations did not matter, while others focused on the difficulty of losing the increased weight after delivery could lead to low self-esteem. Some also thought too much weight gain could lead to health problems, difficult childbirth, gestational diabetes, and a big baby. In summary, most women felt low GWG was risky to the infant, but none recognized excessive maternal weight gain could be detrimental to the infant beyond having a higher birth weight infant.

The results of this study reflected the emphasis of weight within the American culture and the responses of the Hispanic women were aligned with those of the White women. In this study, women placed greater importance on weight gain, not recognizing adverse effects other than high birth weight of the infant. This lack of knowledge of expected weight gain during pregnancy merits further exploration. Black women stated weight gain below the recommendations could be a result of inaccurate healthcare provider advice. It is important for healthcare providers to educate women about the IOM recommendations based on pre-pregnancy BMIs because those who gain within the guidelines can reduce the risk of pregnancy complications, long-term weight retention, obesity, and improve overall health. Providers should also continue to assess and educate women after pregnancy by encouraging healthy behaviors contributing to ideal weight.

Both inadequate or excessive pregnancy weight gain are associated with higher risk of adverse pregnancy outcomes. A low weight gain has been associated with poor

fetal development, low birth weight, and an increased risk for preterm delivery particularly underweight and normal weight women (Schieve et al., 2000). High weight gain has been associated with adverse outcomes, including a greater probability of postpartum weight retention. Normal, overweight, and obese women who gained excessive weight were more likely to have retained more weight 15 years after pregnancy compared to women who gained the recommended amount of weight during pregnancy (Linne, Dye, Barkeling, & Rossner, 2004). A higher risk of preeclampsia and large for gestational age babies were also seen in normal weight and underweight women who had excessive gestational weight gain (Cedergren, 2006). This points to the need to educate women on appropriate pregnancy weight gain specific to their own pre-pregnancy weight, with the aim of optimizing pregnancy outcomes and women's health.

Healthcare Providers' Influence on Gestational Weight Gain Patterns

Women's misinformation about appropriate gestational weight gain, attitudes and beliefs about weight, and weight gain, as well as healthcare providers' inaccurate or absent advice regarding GWG can affect the weight women gain during pregnancy. Based upon their findings resulting from a mixed method study, Brown and Avery (2012) argue the advice women receive antenatally on weight gain, diet, and exercise is brief and generally not related to weight management. A lack of detailed and personalized advice on weight gain leads women to seek information from possible de-regulated sources and could increase their anxiety levels. The study findings indicated significantly more overweight and obese women incorrectly identified weight gain recommendations compared to normal weight and underweight women. Overweight and obese women tend

to overestimate, while underweight and normal weight women tend to underestimate the weight gain during pregnancy.

Many obstetricians do not adjust their GWG advice according to pre-pregnant BMI, and over half believe their education on weight management in pregnancy is inadequate or does not exist at all (Callaway, O'Callaghan, & McIntyre, 2009; Power, Gogswell, & Schulkin, 2009; Stothland, Haas, Brawarsky et al., 2005). In a study conducted by Stewart, Wallace, and Allan (2012), a higher proportion of obstetrical staff than midwives reported they did not weigh women at any time (43% vs 13%; $p < 0.05$). Twenty-two percent reported not advising, most identified no particular reason for omission, 5% felt uncomfortable discussing weight, and 4% were worried that discussing weight could cause undue concern to the patient. Four of the 103 healthcare provider respondents indicated appropriate weight gain for pregnant women in the different pre-pregnant weight categories based on the IOM guidelines and most recommended less than the recommended ranges. Over three quarters of the respondents (78%) indicated their training and education about GWG was inadequate; there were no significant differences between midwives and obstetricians.

Health Promotion Model

Nola Pender's Health Promotion Model (HPM) was created to explain and predict health-promoting components of lifestyle (Pender, Murdaugh & Parsons, 2011). The model is used to assess an individual's background and perceived perceptions of self among other factors to predict health behaviors. The major concepts of the HPM are individual characteristics and experiences, behavior-specific cognitions and affect, and behavioral outcome. Each concept in the model applies to a

specific area of patient assessment. Personal factors in the model are biological, psychological, and sociocultural, making it clear which personal factor is being considered.

Pender deconstructs the environment into what she defines as interpersonal influences (i.e., providers) and situational influences. The diagram is structured in a way that the key concepts are clearly organized under the three headings: individual characteristics and experiences, behavior-specific cognitions and affect, and behavioral outcome. Pender (1996) outlines specific assumptions the model is based on and emphasizes the fact that patients have an active role in their health behaviors. Another assumption is that health professionals exert an interpersonal influence on patients throughout their lives (Pender, 1996). Pender used her model in research studies and revised it to be more applicable to all populations (Peterson & Bredow, 2009); thus, it is appropriate to study childbearing women and GWG pattern outcomes.

Health promotion is critical to the well-being of pregnant women and to nurse researchers developing specific interventions to help this population by reinforcing and identifying strengths in the individual, reiterating benefits of change, and identifying and setting specific goals to reach desired outcomes. According to Peterson and Bredow (2009), this model has changed the focus of the role of the nurse from simply disease prevention to health promotion. Pender's model is useful to nurses because it expands their role to promote good health as opposed to just decreasing patients' risk for becoming ill. The nurse's goals are now aimed at strengthening resources, potentials, and capabilities for each patient and providing resources and education to promote improved health and a better quality of life (Peterson & Bredow, 2009). Not

only does the model expand the role of the nurse, but by focusing on self-efficacy it also puts patient health into patients' own hands, allowing them to be agents of change. This model allows patients and nurses to work together to achieve better outcomes. The results of this study using this model will provide the basis for further intervention to decrease the prevalence of inadequate GWG with its accompanying adverse outcomes.

The HPM will inform this study along with the conceptual framework. Conceptual frameworks are simultaneous guides for and products of an iterative, ever-evolving process that happens through dialog and internal processes of meaning on the part of the researcher, processes that challenge and refute, as well as support and uphold specific theoretical and ideological influences on the research (Ravitch & Riggan, 2012). As outlined in Chapter 1, the HPM will help inform the retrospective chart review study and support the conceptual framework. The conceptual framework and the HPM will form the basis to provide a reasonable rationale for the research questions and method and will identify factors facilitating undesired outcomes of GWG patterns by exploring socio-demographic, interpersonal, and personal characteristics.

Pender's HPM has been used by numerous nurse research scholars and has been helpful in explaining and predicting specific health behaviors. In a study by Schlickau and Wilson (2005), Pender's HPM was used to demonstrate understanding and increasing breastfeeding behaviors in Hispanic women. Another study used the HPM to explore the complex interaction between biological, psychological, and sociological processes that influence health behaviors in individuals to promote prevention and early recognition of malignant melanoma (Torrens & Swan, 2009). Callaway, Canaval and Sanchez (2009),

used the HPM to establish the relationship between lifestyle for prevention of cervical and breast cancers and perceptual cognitive factors. When used in research, the HPM can yield results that will be instrumental in the development of effective health promotion education and counseling related to health risks.

This model will inform this study by helping the investigator to understand the major determinants of health behaviors needed to form the basis for behavioral counseling to promote healthy lifestyles (Pender, Murdaugh & Parsons, 2011). The specific parts of the health promotion model to be used in this study will include Individual Characteristics and Experiences such as Personal Factors (pre-pregnancy BMI, GWG, age, race/ethnicity, SES), and clinical characteristics such as parity. Interpersonal influences would include specific providers (obstetricians vs. midwives) and managed care organizations vs. government-funded clinics.

This research will study variables that can predict as well as show correlations to potential outcomes relating to GWG patterns. The nurse researcher will assess the participants on some of the relevant factors of this model by using a quantitative design approach through retrospective chart review. Pender's positive views of health permits the development of nursing interventions that are not limited to decreasing risks for disease, but are aimed at strengthening resources, potentials, and capabilities. Results of this study will assist healthcare providers and women of childbearing age to commit to an action plan to achieve high-level wellness and self-actualization for these women.

Conclusion

This review of the literature highlighted the current obesity epidemic and the potential increased risk of adverse pregnancy outcomes and variables associated with

GWG patterns. Pregnant women and their healthcare providers should work together to limit excessive and inadequate weight gains during pregnancy by adhering to the 2009 IOM GWG recommendations. Observational data suggest weight loss prior to pregnancy may reduce risks of obesity-related pregnancy complications. Although obesity screening has not been well studied in women of reproductive age, the effect of obesity and the potential for significant maternal and fetal benefits make screening of women during the childbearing years an essential part of the effort to reduce the impact of the obesity epidemic (Zera et al., 2011).

Little is known about the relationship between obesity and postpartum depression. Given the complex relationship between obesity and depression in general, future studies on this issue are warranted. Closer collaboration among obstetricians, nurse midwives, nurse educators, dietitians, obesity specialists, endocrinologists, and researchers may lead to the development of new and more effective methodologies to study and treat alteration in pre-pregnancy BMI prior to and throughout pregnancy as well as in the postpartum period. Future studies using the obesity risk scale should be used to investigate healthcare providers' obesity health risk knowledge and the impact of that knowledge on attitudes to obesity and their approach to treatment. Doctors, nurses, and dieticians all potentially represent important agents for obesity-related behavioral changes, but the extent of their intervention with overweight and obese patients is likely to depend upon their recognition of the consequences of obesity.

CHAPTER III

METHODOLOGY

The purpose of this study was to examine gestational weight gain patterns among a group of racially, ethnically, economically diverse women who were admitted to and gave birth at a large multi-hospital healthcare system in San Diego County between January 1, 2011 and December 31, 2012. Information gained from a retrospective chart review provided insight into GWG patterns and whether women were receiving adequate advice about and following the 2009 IOM GWG guidelines.

The specific aims of this study were to:

1) Analyze the concept of gestational weight gain
2) Describe a sample of women who were admitted and gave birth at a large multi-hospital healthcare system in San Diego County between January 2011 and December 2012
3) Examine the characteristics of women whose weight gain was above, within, or below the 2009 IOM-recommended GWG guidelines based on pre-pregnancy BMI
4) Examine correlates of GWG patterns in women whose weight gain was within the 2009 IOM-recommended guidelines based on pre-pregnancy BMI

Specific characteristic and variables that were looked at include description of socio-demographic information (SES, medical insurance status, age, marital status, primary language, race/ethnicity, smoking, alcohol consumption, illicit drug use), clinical characteristics for the woman (parity, gestational age, pre-pregnant BMI, GWG, mode of delivery), health care provider, and GWG patterns among pregnant women. Clinical characteristics for the newborn were obtained to include Apgar scoring at 1 minute and 5 minutes, term or preterm, gestational age, and size. Other information obtained were Pitocin induction and augmentation, failed induction, live births, postpartum complications such as postpartum hemorrhage and postpartum infection) and associations with GWG patterns.

Information gained from a retrospective chart review provided insight into GWG patterns and whether women are receiving adequate advice about and following the 2009 IOM GWG guidelines. This chapter includes a description of the design, sample, data collection, and analytical procedures. The protection of human subjects is also addressed.

Research Design

A descriptive, correlational, cross-sectional design using retrospective data abstraction from medical records was employed for this study. The aims and research questions lend themselves to a quantitative method to understand what factors or variables contribute to or influence an outcome. This design is intended to facilitate understanding of factors that correlate to variations in gestational weight gain patterns.

Descriptive research provides an accurate portrayal of characteristics of a particular individual, situation, or group. These studies are a means of discovering new meaning, describing what exists, determining the frequency with which something

occurs, and categorizing information. Correlational research is the systematic investigation of relationships among two or more variables, without necessarily determining cause and effect. In correlational research, investigators do not control the independent variables, which often have already occurred and do not elucidate cause and effect. Retrospective design tries to link an existing phenomenon to phenomena that had occurred in the past and the researcher begins with a dependent variable to examine if correlations existed with one or more independent variables (Polit & Beck, 2012).

Data Collection

Retrospective data were obtained from the electronic medical records (EMRs) of all women seeking perinatal services at the two birth centers of a large healthcare system in San Diego County from January 1, 2011 through December 31, 2012. The two hospitals are part of a healthcare system serving the Northern San Diego County region that is the largest healthcare district, serving communities in an 850-square-mile area, with a trauma center that covers more than 2,200 square miles of South Riverside and North San Diego Counties. There are approximately 400-combined births per month at these two birth centers.

Sample

A purposive sampling method was used in this study. Participants included women seeking medical services at the two hospital birth centers who delivered babies between January 2011 and December 2012. Exclusion criteria included women without documented pre-pregnancy BMI and GW and women who had multiple gestations, stillbirths, and no prenatal care (defined as having < 4 office visits). An investigator-developed data abstraction form was used to manage the data.

Dependent Variable

Gestational Weight Gain and Patterns

Gestational weight gain, also called maternal weight gain, refers to the weight gained from conception to delivery. In 2009, the IOM published recommended weight gain parameters based on pre-pregnancy BMI for optimal infant health. Maternal weight gain is considered to be a major determinant of birth weight as well as infant mortality, morbidity, and maternal outcomes. *Ideal weight* is defined as a total weight gain within the range recommended by the IOM for each pre-pregnancy BMI classification. The ideal weight gain recommendations by IOM are considered targets for identifying women who should be evaluated for inadequate or excessive gains (IOM, 2009). A developmental health objective re-established in Healthy People 2020 (2014) was to increase the proportion of mothers who achieve the recommended weight gain during pregnancy. Table 2 displays the recommended pregnancy weight gain based on pre-pregnant BMI.

Table 2

2009 IOM Gestational Weight Gain Recommended Guidelines

Pre-pregnancy BMI Category	Total Weight Gain
Underweight (< 18.5 kg/m^2)	28 - 40 lb.
	12.5 - 18 kg
Normal weight (18.5-24.9 kg/m^2)	25 – 35 lb.
	11.5 – 16 kg
Overweight (25.0- 29.9 kg/m^2)	15 – 25 lb.
	7-11.5 kg
Obese (≥ 30 kg/m^2)	11-20 lb.
	5-9 kg

Note: BMI = body mass index; CDC = Centers for Disease Control and Prevention; IOM = Institute of Medicine; IOTF = International Obesity Task Force.

Less than (<) Ideal Weight Gain is defined as a total weight gain below the limit recommended by IOM for each pre-pregnancy BMI classification. Women with a low pre-pregnancy BMI and gestational weight gain are more likely to have a low birth weight infant. During the second and third trimesters low maternal weight gain is a determinant of fetal growth and is associated with smaller average birth weights and increased risk of delivering an infant with fetal growth restriction (IOM, 1990).

Greater than (>) Ideal Weight Gain is a total weight gain that exceeds the upper range of the IOM recommendation for each pre-pregnancy BMI classification. High maternal weight gain has been recognized as a common nutritional problem in the US, with the prevalence being highest among low-income Black and Hispanic women. Macrosomia, increased risk of cesarean deliveries, and possibly, spontaneous preterm delivery are all associated with very high gestational weight gain. In adolescents, increased weight gain during pregnancy is associated with neonatal complications (IOM, 1990).

Independent Variables

Pre-Pregnancy Body Mass Index (BMI)

Pre-pregnancy BMI (kilogram/meter^2) was calculated from height and weight recorded in the labor and delivery (L&D) EMRs and was categorized according to the 2009 IOM guidelines. Pre-pregnancy BMI is a woman's measure of weight for height before becoming pregnant. The BMI cut-point values specified by the IOM in 2009 are commonly used to classify women as underweight, normal weight, overweight, or obese prior to pregnancy and are a determinant of weight gain during pregnancy and birth weight.

Underweight

Underweight is defined as BMI below 18.5 prior to pregnancy. The lower a woman's weight-for-height or BMI, the more likely she is to be undernourished. Women who are underweight prior to pregnancy are at a higher risk for having a low birthweight infant, fetal growth problems, perinatal mortality, and other pregnancy complications (IOM, 1990).

Normal Weight

Normal weight is defined as a BMI between 18.5 and 24.9.

Overweight

Overweight is defined as a BMI between 25.0 and 29.9. Being overweight prior to pregnancy is a risk factor for postpartum weight retention of prenatal weight gain (IOM, 1990).

Obese

Obesity is defined as a BMI greater than or equal to 30.0. Obese women are at greater risk of delivering a macrosomic infant and experiencing shoulder dystocia and other complications (IOM, 1990). Obese women are also more likely to develop gestational diabetes.

Maternal Outcomes

Maternal outcomes refers to medical complications during pregnancy and include gestational diabetes, pregnancy induced hypertension, premature labor, other medical and obstetrical complications during pregnancy and/or the postpartum period.

Infant Outcomes

Infant outcomes refer to weight at birth, APGAR scores at one and five minutes after birth, gestational age at birth, and congenital abnormalities. Gestational age will be calculated from the first day of the woman's last menstrual period to the date of delivery.

Term

Term refers to delivery between 37-42 weeks gestation. Preterm is delivery that takes place between 20-37 weeks gestation. Post-term is delivery after 42 weeks gestation.

Personal Characteristics

Personal characteristics are defined as characteristics of the pregnant women that affect health-promoting behaviors.

Socio-demographic. Socio-demographic is a multidimensional construct usually composed of age, race/ethnicity, marital status, and language.

Income (SES). This refers to the woman's average monthly household income. However, this was not available in the charts so the woman's medical insurance was used as her socioeconomic status (SES). If a woman had private medical insurance she was considered higher SES; if a woman had government-funded medical insurance, she was considered lower SES.

Age. Age is defined as the number of years since birth when the woman delivers her baby.

Language. The primary language spoken and understood by the women.

Marital Status. The marital status of a pregnant woman could be single, married, separated, divorced, or widowed.

Race/Ethnicity. The term *race* refers to differences and similarities in biological traits deemed by society to be socially significant, meaning that people treat other people differently because of them. For instance, while differences and similarities in eye color have not been treated as socially significant, differences and similarities in skin color have. *Ethnicity* refers to shared cultural practices, perspectives, and distinctions that set apart one group of people from another. The most common characteristics distinguishing various ethnic groups are ancestry, a sense of history, language, religion, and forms of dress.

Parity

Parity refers to the number of times a woman had been pregnant for 20 or more weeks, regardless whether the infant was dead or alive at birth (The current pregnancy was not included and parity does not account for any miscarriages.). Parity has been shown to impact the long-term health status of women and pregnancy outcomes, specifically birth weight, for some groups. A number of studies show first-born children have a lower mean birth weight and are at greater risk of low birth weight than subsequent children (Cogswell and Yip, 1995; IOM, 1985; Kramer, 1987). Multiparity at a young age (under 20 years) increases the risk of delivering a low birth weight baby (IOM 1990; Kramer 1987), and increased parity is associated with excessive maternal postpartum weight retention (Parker & Abrams, 1993) and iron deficiency (Looker et al., 1997).

Apgar Scoring

Apgar scoring at 1 minute and 5 minutes after birth was obtained. A score of 8-10 is normal, while a score of 4-7 indicates an infant that needs some resuscitation and a

score of 3 or lower indicates an infant that requires immediate attention and resuscitation (Perry et al., 2009).

Vaginal Delivery/Caesarean Delivery

Vaginal delivery is the delivery of the baby through the vagina. Caesarean delivery is a surgical incision into the uterus to deliver a baby.

Infant birth weight and size. Low birth weight is defined as a weight at birth of < 2500 grams or 5.5 pounds, considered small for gestational age (SGA). Birth weights between 2501 and 3999 grams are appropriate for gestational age (AGA) and birth weights > 4000 grams or 8.8 pounds are large for gestational age (LGA) and can be considered macrosomia at any weeks gestation (ACOG, 2005).

Preterm birth. Preterm birth refers to delivery before 37 weeks gestation. Preterm births are the largest contributor to neonatal, infant, and perinatal mortality in the U. S. and can be minimized by preventing problems like anemia and inappropriate weight gain through nutritional intervention (IOM, 1990). Other factors related to increased risk of preterm delivery include low income, ethnic background (particularly for Black women), young age, smoking, and low education attainment (IOM, 1990).

Full-term low birth weight. Full-term low birth weight refers to infants born at or after 37 weeks weighing less than 2500 grams. This indicator is one of several used to diagnose intrauterine growth retardation or fetal growth restriction. In these infants gestational age is not the issue because the pregnancy is complete; however, poor maternal nutrition is cited as one of the many causes of full-term low birth weight. (IOM 1996; March of Dimes Foundation, 2013). An infant's size at birth is very important, as

fetal growth restriction contributes to the risk of respiratory distress, hypoglycemia, and other problems (IOM, 1990).

Oxytocin (Pitocin) induction or augmentation. *Induction* is the administration of oxytocin (Pitocin) to the mother through intravenous infusion prior to delivery to initiate labor. *Augmentation* is the administration of oxytocin (Pitocin) via intravenous infusion to potentiate the process of a labor that has already commenced.

Live birth. Live birth refers to a newborn delivered alive (having a heartbeat).

Stillbirth. A stillbirth occurs when a baby is delivered with no heartbeat and is pronounced dead at delivery.

Postpartum Complications

Postpartum complications are adverse events that occur after the delivery of the baby and placenta and up to 6 weeks after delivery of the newborn. These conditions may include hemorrhage, infection, embolus, wound dehiscence or evisceration, pulmonary edema, cardiac arrest, or stroke.

Data Collection Procedure and Human Subjects Protection

Data collection took place over a six-month period after obtaining institutional review board (IRB) approvals from the University of San Diego (USD) and the healthcare system in charge of the two birth centers (Appendix A and Appendix B). A waiver of consent was obtained since identifying data was not be extracted from the charts; only the variables being studied and codes were used. HIPAA regulations and guidelines were enforced in order to protect the identities of women whose data was included in the study. A numeric coding system was used when collecting the data to ensure patient confidentiality and de-identifiers were employed to protect women's

identities. Data obtained were stored only on the researcher's password-protected computer and will be destroyed after three years. Figure 3 below describes the flow of the study.

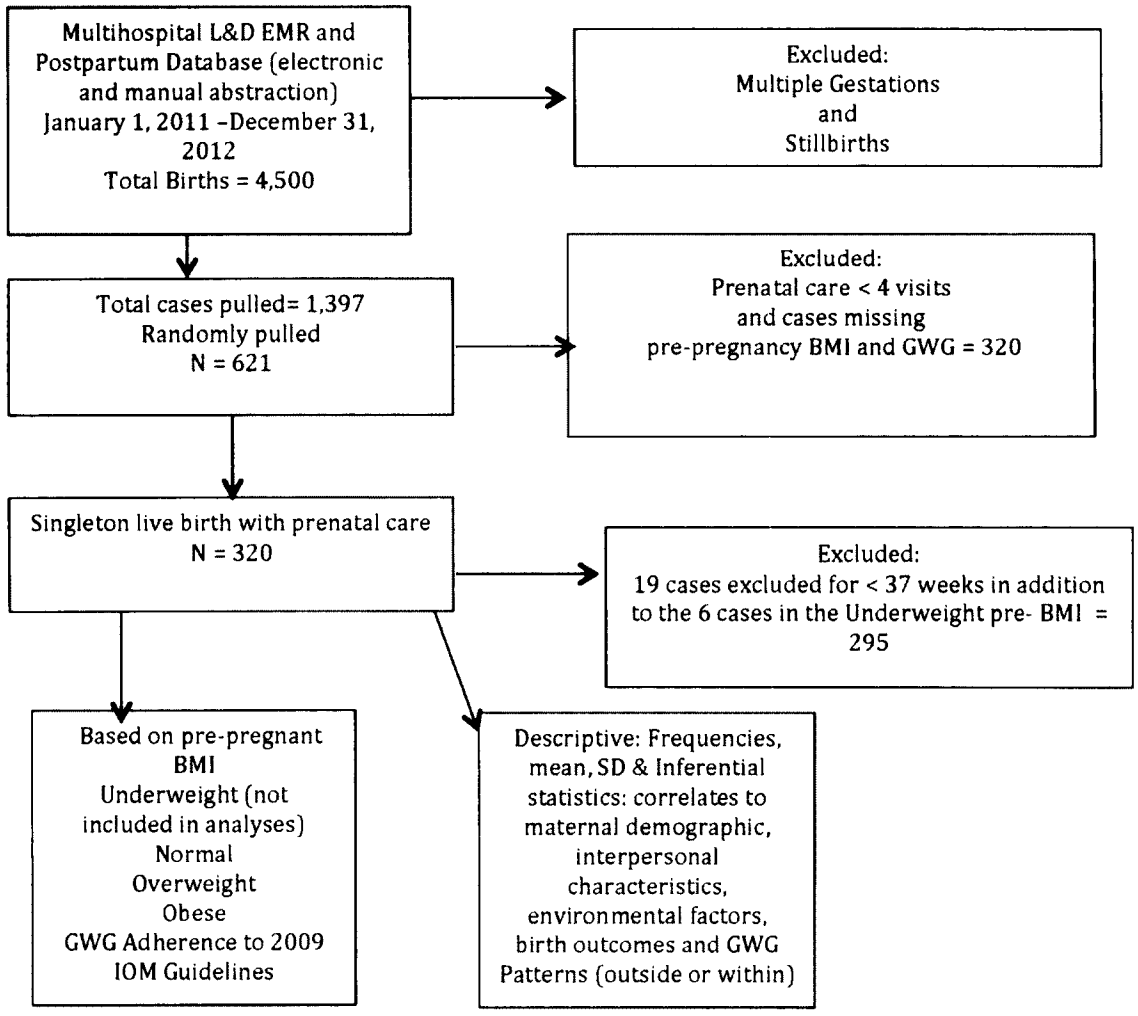

Figure 3. Consort diagram.

Results

Power, Effect, and Sample Size

The appropriate sample size for this study was determined by calculating the effect size, the desired power, and an acceptable level of significance of $\alpha < .05$ or .01.

Effect size is the degree in which a phenomenon exists and can be small (.20), medium (.50), or large (.80). Power ranges from .70-.90 (Cohen, 1988).

According to Polit and Beck (2012), power analysis is used to decrease the chances of Type II errors, thus adding to the validity of the statistical analysis by estimating how big the sample size should be to yield statistical significance. The effect size is the estimated population effect size and this determines the magnitude of the relationships between the independent and dependent variables.

If conventions cannot be avoided, the researcher is encouraged to use conservative estimates to minimize the risk of obtaining non-significant results such as Cohen's *d*. Cohen's (1988) conversion of estimating effect size will be used if there is no information from prior studies. The formula $d = (\mu_1 - \mu_2) \div \sigma$ where *d* = difference in two population means divided by the population standard deviation to yield the estimated effect size. The formula N = [L] / [v] + *k* + 1 was used to calculate power analysis for this study where N = estimated number of cases needed; L = tabled value for a specified α and power; v = estimated effect size; *k* = number of predictor variables. The study includes one dependent variable and 20+ independent variables. Cohen's formula was applied to determine appropriate sample size. The researcher selected a power of .80, an alpha of .05, moderate effect size of R^2 of 0.13. Based on the formula, a sample size of at least 250 participants was needed to provide sufficient power for this study (Polit & Beck, 2012; Cohen, 1988).

Statistical Analysis

All data analysis was conducted using SPSS version 22.0. Descriptive and inferential statistics were used to calculate the results. Multivariate statistics were employed since there were more than two variables involved in this study. Prior to analysis, the data set was screened for missing data and any violation for assumption of normality. Descriptive statistics were obtained to identify any correlation between dependent variable and independent variables including demographic data and description of the sample characteristics. Frequency distributions for variables were depicted using tables. The central tendency of the mean, mode, median, and standard deviation were obtained. Skewness and kurtosis for each continuous variable were examined for normality.

Correlation estimates the degree to which variables relate to one another. It is a single number that describes the degree of relationship between the two variables known as the correlation coefficient, a numeric measure of the strength of linear relationship between two random variables (Munro, 2013). Understanding potentially related attributes helped the nurse researcher to better understand which physiological or demographical data were associated with the reasons of concern. Pearson product-moment correlations (r) and analysis of variance (ANOVA) were used to determine association among continuous variables; Chi-square Pearson's correlation and Fisher's Exact analyses were used to compare categorical variables (Mertler & Vannatta, 2010; Munro, 2013; Polit, 2010). Cramer V was also used to assess strengths of relationships. Pearson's r was calculated as a measure of the linear relationship between two quantitative measured variables. The value range for r is -1 to +1. When the correlation is

0, there is no relationship between the variables. If the correlation is positive, the two variables are related and if the correlation is negative, there is an inverse relationship. The strength of the relationship is measured by r^2. The established p value will be set at .05.

In addition to the descriptive analysis and correlational designs, the researcher used multivariate logistic regression, the analytic technique of choice when there are two or more categorical predictors and when there are one or more continuous predictors. Logistic regression coefficient is the natural logarithm of the odds ratio (OR) and the OR is the multiplicative increase in the odds of the Y (outcome variable) event that goes together with a one-unit increase in X (predictor variable). The odds ratio is often used as a substitute for the relative risk, which could mean the risk of Y –event increases when the risk factor for X increases by one unit. Simply speaking, logistic regression tests the relationship between two or more independent variables and one dependent variable (gestational weight gain pattern) to predict the odds of an event or an outcome or to estimate relative risk (Polit, 2013).

Table 3 lists the study variable measures based on the research questions. The three categories in GWG pattern that were assessed were *above, within*, and *below* the 2009 IOM GWG guidelines.

Table 3

Variable Measures

Variable Dependent (DV) or Independent (IV)	**Research Question**	**Level of Measurement**	**Statistical Analysis**
Gestational Weight Gain Guideline Patterns (DV)	1. What are the characteristics: a) pre-pregnant BMI, b) age, c) race/ethnicity,	Nominal (GWG) Categorical outcome (below, within range, or above GWG guidelines)	Descriptive, Chi-square Correlations for variables at the Nominal level of

	d) parity, e) medical insurance, f) marital status and the 2009 IOM GWG guideline patterns?	Then dichotomous (Within and Outside recommended guidelines)	measurement) Pearson's correlation and ANOVA for variables at the continuous).
a) Pre-pregnant BMI (IV)	What are correlates between maternal characteristics: a) pre-pregnant BMI, b) age,	a) Nominal (BMI): categorical -underweight, normal, overweight, obese	Multivariate Logistic Regression with the IVs and the DV (GWG within recommended)
b) Age (IV)	c) race/ethnicity, d) parity, e) medical	b) Nominal (age)	
c) Race/ethnicity (IV)	insurance, f) marital status and the 2009 IOM GWG	c) Nominal (Dichotomous)	
d) Parity (IV)	guideline patterns?	d) Interval (continuous)	
e) Medical Insurance (IV)		e) Nominal	
f) Marital Status (IV)		f) Nominal	
Newborn Characteristics a) Birth weight b) Apgar scoring 1 and 5 minutes	2. What are the characteristics to newborn characteristics: a) birth weight, b) Apgar scoring at 1 and 5 minutes, newborn size and 2009 IOM GWG guideline patterns? What correlates to newborn characteristics: a) birth weight, b) Apgar scoring at 1 and 5 minutes, newborn size and 2009 IOM GWG	a) Interval (continuous) b) Interval	Descriptive, Pearson's Correlation, Logistic Regression with the IV's and DV

	guideline patterns?		
Adherence to GWG Recommended Ranges	3. Based on the women's GWG, what percentage of women are adhering to the 2009 IOM guideline patterns?	Ratio	Descriptive Frequencies Pearson's Correlation
Mode of Delivery: (Cesarean delivery Vaginal delivery) (IV)	Are there any relationships between adverse birth outcomes and GWG Patterns?	Nominal	Frequencies, Correlation and Logistic Regression with the DV
Maternal complications (IV) (Postpartum hemorrhage and postpartum infection)	Are there any relationships between maternal complications and GWG Patterns?	Nominal	Frequencies
Type of Healthcare provider (Midwife or MD/Obstetrician) (IV)	Is there a relationship between specific health care providers and GWG Patterns?	Nominal	Frequencies, Correlation and Logistic Regression with the DV
Type of Medical Insurance: (Government funded or private)	Is there a correlation between medical insurance and GWG Patterns?	Nominal	Correlation and Logistic Regression with the DV
Gestational age	Is there a correlation between gestational age and GWG Patterns?	Interval	Frequencies, Correlation and Logistic Regression with the DV
Pitocin Induction or Augmentation	What is the frequency of Pitocin induction, Pitocin augmentation and failed induction?	Nominal	Frequencies

Statistical Assumptions

Logistic regression can handle all sorts of relationships, because it applies a non-linear log transformation to the predicted odds ratio. Secondly, the independent variables

do not need to be multivariate normal although multivariate normality yields a more stable solution. Homoscedasticity is not needed as logistic regression does not need variances to be heteroscedastic for each level of the independent variables. It can handle ordinal and nominal data as independent variables. A good approach to ensure this is to use a stepwise method to estimate the logistic regression. Also, the model should have little or no mulicolinearity—that is, the independent variables should be independent from each other. However, there is the option to include interaction effects of categorical variables in the analysis and the model (Mertler & Vannatta, 2010).

References

Agency for Healthcare Research and Quality (AHRQ). (2008). *Evidence report/technology assessment number 168: Outcomes of maternal weight gain.* Publication No. 08-E009. Rockville, MD: AHRQ.

Aly, H., & Hammad, T. (2010). Maternal obesity associated complications and risk of prematurity. *Journal of Perinatology, 30*, 447-451.

American College of Obstetricians and Gynecologists (ACOG). (2005). The importance of preconception care in the continuum of women's health. committee opinion number 313. *Obstetrics and Gynecology 106*(3), 665-666.

Amorin, A. R., Rossner, S., Neovius, M., Lourenco, P. M., & Linne, Y. (2007). Does excess pregnancy weight gain constitute a major risk for increasing long-term BMI? *Obesity* (Silver Spring), *15*(5), 1278–1286.

Anderson, J. E., Ebrahim, S., Floyd, L., & Atrash, H. (2006). Prevalence of risk factors for adverse pregnancy outcomes during pregnancy and the preconception period-United States, 2002-2004. *Maternal Child Health Journal, 10*(s), 101-106. doi: 10.007/s10995-006-0093-z.

Barker, B. (1995). Fetal origins of coronary artery disease. *British Medical Journal, 311*, 171-174.

Bhattacharya, S., Campbell, D. M., Liston, W. A., & Bhattacharya, S. (2007). Effects of body mass index on pregnancy outcomes in nulliparous women delivering singleton babies. *BioMed Central Public Health 7*, 1-10.

Brown, A., & Avery, A. (2012). Healthy weight management during pregnancy: What advice and information is being provided. *J Hum Nutr Diet. 25*, 378-388 Doi: 10.1111/j.1365-277X.2012.01231.x

Callaway, K., Canaval, G. E., & Sanchez, M. N. (2009). Lifestyle and cancer prevention in female employees at a health institution. *Columbia Medical 42*(2), 177-183.

Callaway, K., O'Callaghan, M. J., & McIntyre, H.D. (2009). Barriers to addressing overweight and obesity before conception. *Medical Journal of Australia, 19*(8), 425-428.

Catalano, P. M. (2007). Management of obesity in pregnancy. *Obstetrics and Gynecology 109*, 419-433. [PubMed].

Catalano, P. M., Farrell, K., Thomas, A., Huston-Presley, L., Mencin, P., Hauguel de Mouzon, & Amini, S. B. (2009). Perinatal risk factors for childhood obesity and metabolic dysregulation. *American Journal of Clinical Nutrition 90*, 1303-13.

Cawley, J., & Meyerhoefer, C. (2012). The medical cost of obesity: An instrumental variables approach. *Journal of Health Economics, 31*,(1), 219. doi: 10.1016/j.jhealeco.2011.10.003.

Centers for Disease Control and Prevention (CDC). (2009). State-specific prevalence of obesity among adults- United States. *Morbidity Mortal Weekly Report*, *59*(30), *951-5.*

Centers for Disease Control and Prevention (CDC). (2007). Recommendations to improve preconception health and health care-United States. Report of the

CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception care. *Morbidity Mortal Weekly Report, 55*, 1-25.

Cedergren, M. I. (2006). Effects of gestational weight gain and body mass index on obstetric outcome in Sweden. *International Journal Gynecology and Obstetrics 93*(3), 269-274.

Cedergren, M. I. (2004). Maternal morbid obesity and the risk of adverse pregnancy outcome. *Obstetrics & Gynecology, 103*(2), 219-24.

Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Solomon, C. G., & Markenson, G. (2008). Predictors of excessive and inadequate gestational weight gain in Hispanic women. *Obesity, 16*(7), 1657- 1666.

Chmitorz, A. von Kris, R., Rasmussen, K. M., Nehring, I., & Ensenauer, R. (2012). Do trimester-specific cutoff predict whether women ultimately stay within the Institute of Medicine/National Council Guidelines for gestational weight gain? Findings of a retrospective cohort study. *American Journal of Clinical Nutrition, 95*(6), 1432-1437.

Chua, S. C., Kim, S. Y., Schmid, C. H., Dietz, P. M., Callaghan, W. M., & Lau, J. (2007). Maternal obesity and cesarean delivery: A meta-analysis. *American Journal of Obstetrics and Gynecology, 8*(50), 385-394.

Chuang, C., Weisman, C., Hillemeier, M., Schwartz, E., Camacho, F., & Dyer, A. M. (2009). Pregnancy intention and health behaviors: Results from the Central Pennsylvania Women's Health Study cohort. *Maternal Child Health Journal.*

Cosgwell, M. E., & Yip, R. (1995). The influence of fetal and maternal factors on the distribution of birthweight. *Seminars in Perinatology, 19*, 222-40.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

deBoo, H. A., & Harding, J. E. (2006). The developmental origins of adult disease (Barker) hypothesis. *Am N Z J Obstet Gyneacol,45*(1), 4-14.

Dietz, P. M., Callaghan, W. M., & Sharma, A. J. (2009). High pregnancy weight gain and risk for excessive fetal growth. *American Journal of Obstetrics and Gynecology, 201*(1), 51-55.

Dipietro, J. A., Miller, S., Costigan, K. A., Gurewitsch, E., & Caufield, L. E. (2003). Psychosocial influences on weight gain attitudes and behaviors during pregnancy. *Journal of the American Dietetic Association, 103*(10), 1314-1319.

Donahue, S. M., Rifas-Shiman, S. L., Gould, D. R., Jouni, Z. E., Gillman, M. W., Oken, E. (2010). Prenatal fatty acid status and child adiposity at age 3: results from a US pregnancy cohort. *American Journal of Clinical Nutrition, 9(*4), 780-788.

Donahue, S. M., Zimmerman, F. J., & Starr, J. R. (2010). Correlates of physical activity at two points during pregnancy. *J Phys Act Health, 9*(3), 325-335.

Dowda, M., Ainsworth, B., Addy, C. C., Saunders, R., & Riner, W. (2003). Correlates of PA among U.S. young adults 18-30 years of age from NHANES 111. *Annals of Behavioral Medicine, 26*(1), 15-23.

Eyler, A. E., Wicox, S., Matson-Koffman, D., Evenson, K. R., Sanderson, B., Thompson, J., Wilbur, J. & Rohm-Young, D. (2002). *Journal of Women's Health & Gender-Based Medicine, 11*(3), 239-253.

Feig, D., & Naylor, C. (1998). Eating for two: Are guidelines for weight gain during pregnancy too liberal? *Lancet 315:*1054-5.

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults. 1999-2008. *JAMA 303*(3): 235-41.

Fredrick, I. O., Williams, M. A., Sales, A. E., Martin, D. P., & Killien, M. (2008). Prepregnancy body mass index, gestational weight gain and other maternal characteristics in relation to infant birth weight. *Maternal and Child Health Journal, 12*, 557-567.

Galtier, F., Raingeard, I., Renard, F., Boulot, P, & Bringer, J. (2008). Optimizing the outcome of pregnancy in obese women form pregestational to long-term management. *Diabetes Metab, 34,*(1), 19-25.

Gillman, M. W. (2012). Gestational weight gain: now and the future. *Circulation, 125* (11), 1339-40.

Gillum, R. F. & Sempos, C. T. (2005). Ethnic variation in validity of classification of overweight and obesity using self-reported weigh and height in American women and men: the Third National Health and Nutrition Examination Survey. *Nutrition Journal 4:* 27 Retrieved from BioMed Central. Doi: 10.1186/1475-2891-4-27.

Godfrey, J. R., & Nachtigall, M. J. (2009). Conversation with the experts: Toward optimal health: An update of preconception care. *Journal of Women's health 18*(6), 779-783. Doi: 10.1089/jwh.2009.1480.

Goffman, D., Madden, R. C., Harrison, E. A., Merkatz, J. R., & Chazotte, C. (2007). Predictors of maternal mortality and near-miss maternal morbidity. *J Perinatol, 27*,(10), 597-601.

Groth, S. W. (2008). The long term impact of adolescent gestational weight gain. *Res Nurs Health, 31*,108-18.

Groth, S., & Kearney, M. H. (2009). Diverse women's beliefs about weight gain in pregnancy. *American College of Nurse-Midwives, 54,* (6), 452-456.

Guelinckx, I., Devlieger, R., Mullie, P., & Vansant, G. (2010). Effects of lifestyle intervention on dietary habits, physical activity, and gestational weight gain in obese pregnant women: a randomized control trial. *Am*erica Journal of Clinical Nutrition, 91*(2), 373-80.*

Guidelines for Perinatal Care. 6th ed. (2007). Elk Grove Village, IL. Washington, DC: American Congress of Obstetricians and Gynecologists.

Healthy People 2020. (2014). Maternal, infant, and child health. U.S. Department of Health and Human Services. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=26

Han, Z., Lutsiv, O., Mulla, S., Rosen, A., Beyene, J., & McDonald, S. D. (2011). Low gestational weigh gain and the risk of preterm birth and low birthweight: a systematic review and meta-analyses. *ACTA Obstetricia et Gynecologica 90*, 935-954.

Hedley, A. A., Ogden, C. L., Johnson, C. L. Carroll, M. D., Curtin, L. R., & Flegal, K. M. (2004). Prevalence of overweight and obesity among U.S. children, adolescent, and adult, 1999-2002. *JAMA, 291*(23), 284-50.

Hillier, T. A., Pedula, K. L., Schmidt, M. M., Mullen, J. A., Charles, M. A., & Pettitt, D. J. (2007) Childhood obesity and metabolic imprinting: the ongoing effects of maternal hyperglycemia, *Diabetes Care, 30*2287-2292.

Hinton, P. S., & Olson, C. M. (2001). Predictor of pregnancy- associated change in physical activity in rural White population. *Maternal and Child Health Journal, 5*(1), 7-14.

Honoré, P.A., & Scott, W. (2010). Priority areas for improvement of quality in public health. Washington, DC: Department of Health and Human Services. Retrieved from http://www.hhs.gov/ash/initiatives/quality/quality/improvequality2010.pdf

Institute of Medicine (IOM). (2009). Weight gain during pregnancy: Reexamining the Guidelines. Washington, DC: National Academies Press.

Institute of Medicine (IOM). (1990). Nutrition during pregnancy, part 1: Weight gain. Part 11: Nutrients supplements. Washington, DC. National Academies Press.

Institute of Medicine (IOM). (1985). Committee to study the prevention of low birth weight: Preventing low birth weight. Washington, DC: National Academies Press.

Johnson, K., Posner, S. F., Biermann, J., Cordero , J. F., Atrash, H. K., Parker, C. S., et al. (2006). Recommendations to improve preconception health and health care—United States. A group f CDC/ATSDR Preconception Care Work Group and the Select Panel on Preconception Care. *MMWR Recomm Rep 55*(RR-r): 1-23.

Johnson, J. W. & Yancey, M. K. (1995). A critique of the new recommendations for weight gain in pregnancy. *Am J Obstet Gynecol 174: 254-8.*

Kim, S. Y., Dietz, P. M., England, L. Morrow, B., & Callaghan, W. M. (2007). Trends in pre-pregnancy obesity in nine states, 1993-2003 *Obesity, 15*, 986-993.

Kramer, M. (1987). Determinants of low birthweight: Methodology assessment and Meta-analysis. Bulletin *WHO, 65*(5), 663-737.

Kristensen, J., Vestergaard, M., Wisborg, K., Kesmodel, U., & Secher, N. J. (2005). Pre-pregnancy weight and risk of stillbirth and neonatal death. *BJOG, 112*(4), 403-8.

Krummel, D. A. (2007). Postpartum weight control: A vicious cycle. *Journal of the American Dietetic Association, 107*, 37-40.

Linne, Y., Dye, L., Barkeling, B., & Rossner, S. (2004). Long-term weight development in women: a 15 –year follow-up of effects of pregnancy. *Obes Res 12:*1166-78.

Looker, A. C., Dallman, P. R., Carroll, M. D., Gunter, E. W., & Johnson, C. L. (1997). Prevalence of iron deficiency in the United States. *JAMA, 277,*973-976.

Lovell, G. P., El Ansari, W., & Parker, J. K. (2010). Perceived exercise benefits and barriers of non-exercising female university students in the United Kingdom. *International Journal of Environmental Research and Public Health 7*, 784-798. Doi: 10.3390/ijerph7030784

Mamun, A. A., Kinariwala, M., O'Callaghan, M. J., Williams, G. M., Najman, J. M., & Callaway, L. K. (2010). Associations of excess weight gain during pregnancy with long-term maternal overweight and obesity: evidence from 21 y postpartum follow-up. *American Journal of Clinical Nutrition, 91*, 1336-1341.

March of Dimes Foundation. (2013). Your premature baby. Retrieved from http://www.marchofdimes.com/baby/low-birthweight.aspx

Margerison-Zilko, C. E., Rehkopf, D., & Abrams, B. (2010). Associations of gestational weight gain in short-and long-term maternal health outcomes. *American Journal of Obstetrics and Gynecology, 202,*(6), 574.

Martin, J. A., Hamilton, B. E., Sutton, P. D., Ventam, M. A., Menacker, F., Kirmeyer, S., & Matthews, T. J. (2006). Birth: Final data for 2006. Accessed at: www.cdc.gov/nchs/data/nvsr/nvsr57/nvsr57_07.pdf.

Meng, H., Leibel, D., & Wamsley, B. R. (2011). Body mass index and the impact of a health promotion intervention on health services use and expenditures. *Journal of Aging and Health, 23*, Doi: 10.1177/0898264310395755

Mertler, C. A., & Vannatta, R. A. (2010). *Advanced and multivariate statistical methods*. (4th ed.). Glendale, CA: Pyrczak Publishing.

Munro, B. H. (2013). *Statistical method for health care research.* (6th ed.). Philadelphia, PA: Lippincott, Williams & Wilkins.

National Research Council. Maternal nutrition and the course of pregnancy. (1970). Report of the Committee on Maternal Nutrition, Food and Nutrition Board. Washington, DC: National Academy of Sciences.

Nohr, E. A., Vaeth, M., Baker, J. L., Sorenson, T. I. A., Olsen, J., & Rasmussen, K. M. (2008). Combined associations of prepregnant body mass index and gestational weight gain with the outcome of pregnancy. *American Journal of Clinical Nutrition, 87*, 1750-9.

Nuthalapaty, F. S., Rouse, D. J., & Owen, J. (2004). The association of maternal weight with cesarean risk, labor duration, and cervical dilation rate during labor induction. *Obstet Gynecol, 10,*(31), 452-6.

Ochsenbein-Kolble, N., Roos, M., Gasser, T., & Zimmermann, R. (2007). Cross-sectional study of weight gain and increase in BMIs throughout pregnancy. *Eur J. Obstet Gynecol Reprod Biol. 130,* (2), 180- 6.

Ogden, C. L., Carroll, M. D., Curtin, L. R., et al. (2006). Prevalence of overweight and obesity in the United States. *JAMA, 295*(13), 1549-155.

Ogden, C. L., Carroll, M. D., Curtin, L. R. McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States. 1999-2004. *JAMA 296*(13): 1549-55.

Oken, E. & Gillman, M. W. (2003). Fetal origins of obesity. *Obesity Research, 11,*496-506.

Oken, E., Kleinman, K. P., Belfort, M. B., Hammitt, J. K., & Gillman, M. W. (2009). Associations of gestational weight gain with short-and longer-term maternal and health outcomes. *Am J Epidemiol, 170*, 173-80.

Oken, E., Rifas-Shiman, S. L., Field, A. E., Frazier, A. L., & Gillman, M. W. (2008). Maternal gestational weight gain and offspring weight in adolescent. *Obstetric and Gynecology 112*:999-1006.

Olson, C. M. (2008). Achieving a healthy weight gain during pregnancy. *Ann Rev Mutr,* 28, 411-423.

Olson, C. M., & Strawderman, M. S. (2003). Modifiable behavioral factors in a biopychosocial model predict inadequate and excessive gestational weight gain. *J Am Diet Association 103:*48-54.

Olson, C. M., Strawderman, M., S., & Reed, R. G. (2004). Efficacy of an intervention to prevent excessive gestational weight gain. *Am J Obstet Gynecol 191:* 530-536.

Parker, J. D., & Abrams, B. (1993). Differences in postpartum weight retention between black and white mothers. *Obstet Gynecol,81,*766-74.

Parker, J. & Abrams, B. (1992). Prenatal weight gain advice: an examination of the recent prenatal weight gain recommendations of the Institute of Medicine. *Obstet Gynecol 79:* 664-9.

Pender, N. J. (1996). *Health promotion in nursing practice* (3rd ed.). Connecticut, NJ: Appleton & Lange Stanford.

Pender, N. J., Murdaugh, C. L., & Parsons, M. A. (2011). *Health promotion in nursing practice* (6th ed.). Upper Saddle River, NJ: Pearson.

Pereira, M. A., Rifas-Shiman, S. L., S. L., Kleinman, K. P., Rich-Edwards, J. W., Peterson, K. E., & Gillman, M. W. (2007). Predictor of change I physical activity during and after pregnancy: Project Viva. *American Journal of Preventive Medicine, 32,* 312-319.

Perry, S. E., Hockenberry, M. J., Lowdermilk, D. L., & Wilson, D. (2009). *Maternal child nursing care.* (4th ed.). Maryland, Heights, MO: Mosby, Elsevier.

Peterson, S. J., & Bredow, T.S. (2009). *Middle range theories: Application to nursing research* (2nd ed.). Philadelphia, PA: Lippincott, Williams & Wilkins.

Phelan, S., Phipps, M. G., Abrams, B., Darroch, F., Schaffner, A., & Wing, R. R. (2011). Practitioner advice and gestational weight gain. *Journal of Women's Health 20*(4) 585- 591.

Phelan, S., Phipps, M. G., Abrams, B., Darroch, F., Schaffner, A., & Wing, R. R. (2011). Randomized trial of a behavioral intervention to prevent excessive gestational weight gain: the FIT for Delivery Study. *Am J Nutr 93,* 772-779.

Polit, D. F. (2010). *Statistics and data analysis for nursing research.* (2nd ed.). Upper Saddle River, NJ: Pearson Education Inc.

Polit, D. F., & Beck, C. T. (2012). *Nursing research: Generating and assessing evidence for nursing practice.* (9th ed.). Philadelphia, PA: Wolters Kluwer/Lippincott, Williams & Wilkins.

Power, M. L., Cogswell, M. C., & Schulkin, J. (2009). US obstetrician-gynaecologist's prevention and management of obesity in pregnancy. *J Obstet Gynaecolo, 29,*373-7.

Rahman, M. & Berenson, A. B. (2012). Self-perception of weight gain among multiethnic reproductive-age women. *American Journal of Women's Health, 21* (3). doi: 10.1089/jwh.2011.2982.

Rasmussen, K. M., Catalano, P. M., & Yatkine, A. L. (2009). New guidelines for weight gain during pregnancy: what obstetrician/gynecologists should know. *Current Opinion Obstetrician gynecologist, 21* 521-526. Doi: 10.1097/GCO.0b013e328332d24e.

Rasmussen, S. A., Chu, S. Y., Kim, S. Y., Schmid, C. H., & Lau, J. (2008). Maternal obesity and risk of neural tube defects: meta-analysis. *Am J Obstet Gynecol 2008, 198*, 611-619.

Rasmussen, K. M., & Yaktine, A. L. (2009). Institute of Medicine (US). Committee to reexamine IOM pregnancy weight guidelines. *Weight gain during pregnancy: Reexamining the guidelines*. Washington, DC: National Academy Press.

Ravitch, S. M., & Riggan, M. (2012). *Reason & Rigor: How conceptual frameworks guide research.* Los Angeles, CA: Sage.

Rees, G. A., Porter, J., Bennett, S., Colleypriest, O., Ellis, L., & Stenhouse, E. (2011). The validity and reliability of weight and height measurements and body mass index calculation in early pregnancy. *Journal of Human and Dietetics,25,*(2), 117-120.

Rich-Edwards, J. W., Kleinman, K., & Abrams, A. (2006). Sociodemographic of antenatal and postpartum depressive symptoms among women in a medical group practice. *Journal of Epidemiol Community Health, 60*, 221-227.

Rooney, B. L., Schauberger, C. W., & Mathiason, M. A. (2005). Impact of perinatal weight change on long-term obesity and obesity-related illnesses. *Obstetrics & Gynecology, 106*(6) 1349-1356.

Rooney, B. L., & Schauberger, C. W. (2002). Excess pregnancy weight gain and long-term obesity: one decade later. *Obstetric & Gynecology 100*: 245-52.

Salehi, M., Bravo-Vera, R., Sheikh, A., Gouller, A., & Poretsky, L. (2004). Pathogenesis of polycystic ovary syndrome: What is the role of obesity? *Metabolism, 53*(3), 358-76.

Sarwer, D. B., Allison, K. C., Gibbons, L. M., Tuttman-Markowitz, J., & Nelson, D. B. (2006). Pregnancy and obesity: A review and agenda of future research. *Journal of Women's Health 15,* 720-733.

Schieve, L. A., Cogswell, M. E., & Scanlon, K. S., Perry, G., Ferre, C, Blackmore-Prince, C. et al. (2000). Prepregnancy bidy mass index and pregnancy weight gain: Associations with preterm delivery. Obstet *Gynecol, 96,*194-200.

Schieve, L. A., Cogswell, M. E., & Scanlon, K. S. (1998). Trends in pregnancy weight gain within and outside ranges recommended by the Institute of Medicine on a WIC population. *Maternal Child Health Journal 2*: 111-6.

Schlickau, J. M., & Wilson, M. E. (2005). Breastfeeding healthy promoting behavior for Hispanic women literature review. *Journal of Advanced Nursing, 52(*2), 200-210.

Schoenborn, C. A., Adams, P. F., Barnes, P. M., Vickerie, J. L., et al. (2004). Health behaviors of adults: Unites States- 1999-2001. *Vital Statistics Series 10*(219), 1-89.

Setse, R., Grogan, R., Cooper, L. A., Powe, N. R., & Nicolson, W. (2008). Weight loss programs for urban-based postpartum African-American women: perceived barriers and preferred components. *Maternal Child Health Journal, 12*(1), 19-27.

Shah, D. K., & Ginsburg, E. S. (2010). Bariatric surgery and fertility. *Current Opin Obstet Gynecol, 22*,(3), 248-54. Doi: 10.1097/GCO.0b013e328337e9.

Siega-Riz, A. M., & King, J. (2009). Position of the American Dietetic Association and American Society for nutrition, obesity, reproduction, and pregnancy outcomes. *J of Dietetic Assoc, 108*(5), 918-27.

Sivalingam, S. K., Ashraf, J., Vallurupalli, N., Friderici, J., Cook, J., & Rothberg, M. B. (2011). Ethnic differences in the self-recognition of obesity and obesity-related comorbidities: a cross-sectional analysis. *J Gen Intern Med 26*(6): 616-20. Doi: 10.1007/s11606-010-1623-3.

Skouteris, H. Hartley-Clark, L., McCabe, M., Milgrom, J., Kent, B., Herring, S.J., & Gale, J. (2010). Preventing excessive gestational weight gain: a systematic review of interventions. *Obesity Reviews 11*: 757-768. Doi: 10.1111/j.1467-789X.2010.00806.x

Stewart, Z. A., Wallace, E., & Allan, C. (2012). Weight gain in pregnancy: a survey of current practices in a teaching hospital. *Aust N Z J Obstet Gynaecol, 13*(2), 208-210.

Stotland, N. E., Caughey, A. B., Lahiff, M., & Abrams, B. (2006). Weight gain and spontaneous preterm birth: the role of race or ethnicity and previous preterm birth. *Obset Gyneco, 108*(6), 1448-55.

Stotland, N. E., Cheng, Y. W., Hopkins, L. M., & Caughey, A. B. (2006). Gestational Weight gain and adverse neonatal outcome among term infants. *Obstet Gynecol, 108,*(3 Pt 1), 635-43.

Stotland, N. E., Haas, J. S., Brawarsky, P., Jackson, R. A., Fuentes-Afflick, E., & Escobar, G. J. (2005). Body mass index, provider advice, and target gestational weight gain. *Obstetric and Gynecology 105:*633-638.

Stotland, N., Tsoh, J. Y., & Gerbert, B. (2011). Prenatal weight gain: Who is counseled? *Journal of Women's Health 00* (00). Doi: 10.1089/jwh.2011.2922.

Stothard, K. J., Tennant, P. W. G., Bell, R., & Rankin, J. (2009). Maternal overweight and obesity and the risk of congenital anomalies: A systematic review and meta-analysis. *Journal of the American Medical Association 301*, 636-650.

Swift, J. A., Glazebrook, C., & MacDonald, L. (2006). Validation of brief, reliable scale to measure knowledge about the health risk associated with obesity. *International Journal of Obesity, 30,*(4), 661-668.

Takimoto, H., Sugiyama, S., Nozue, M., Kusama, K., Fukuoka, H., Kato, N. (2011). Maternal antenatal body mass index gains as predictors of large-for-gestation-age infants and cesarean delivery in Japanese singleton. *Journal of Obstetrics and Gynaecology Research, 37*(6), 553-562.

Torrens, R., & Swan, A. (2009). Promoting prevention and early recognition of malignant melanoma. *Dermatology Nursing 21* (3):115-122..

Tsai, J. H.-C., Choe, J. H., Lim, J. M. C., Acorda, E., Chan, N. L., Taylor, V., & Tu, S.-P. (2004). Developing culturally competent health knowledge: issues of data analysis of cross-cultural, cross-language qualitative research. *International Journal of Qualitative* Methods, *3*(4), Article 2. Retrieved from http://www.ualberta.ca/iiqm/backissues/3_4/html/tsai.html.

U.S. Preventative Services Task Force. (2003). Screening for obesity in adults: Recommendations and rational. *Annals of Internal Medicine, 139*(11), 930-932.

U.S. Public Health Service Expert Panel on Prenatal Care (USPHSEPPC) (1989). Caring for our future: the content of prenatal care. Washington, DC: Public Health Services.

Vahratian, A. (2009). Prevalence of overweight and obesity among women of childbearing age: Results from the 2002 National Survey of Family Growth. *Maternal Child Health Journal 13:*268-73.

Van de Merwe, M. (2009). Obesity in women-a life cycle of medical risk. *Journal of Endocrinology, Metabolism and Diabetes of South Africa 14*(3), 139-142.

Walker, R. C. (2004). Predicting preschooler obesity at birth: the role of maternal obesity in early pregnancy. *Pediatrics, 114,* (1), 23-36.

Walker, L. O. (2007). Managing excessive weight gain during pregnancy and the postpartum period. *Journal of Obstetric Gynecology 201 (36):* 490-500.

Weiss, J. L., Malone, F. D., Emig, D., Ball, R. H., Nyberg, D. A., & Comstock, C. H., et al., (2004). Obesity, obstetrics complication and cesarean delivery rate-a population-based screening study. *Am J Obstet Gynecol, 190*,(4), 1091-7.

WHO. (2013). What are the main consequences of being overweight? Retrieved from: http://www.who.int/features/qa/49/en/

WHO Expert Consultation. (2004). Appropriate body-mass index for Asian population and its implications for policy and intervention strategies. *Lancet 363,* 157-163.

WHO. (2000). Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser:894*: 1-253.

Wright, C., Bilder, D., DeBlasis, T., Mogul, M., Rubin, D., & Shea, J. A. (2013). Psychosocial factors associated with gestational weight gain in a low-income cohort. *J Health Care Poor Underserved, 1, 332-43.*

Wrotniak, B. H., Shults, J., Butts, S., & Stettler, N. (2008). Gestational weight gain and risk of overweight in the offspring at age 7 y in a multicenter, multiethnic cohort study. *Am Journal of Nutrition, 87*, (6), 1818-1824.

Yaemsiri, S., Slining, M. M., & Agarwal, S. K. (2010). Perceived weight status, overweight diagnoses, and weight control among US adults: the NHANES 2003-2008 Study. *Int J Obs 35*(8), 1063-1070.

Zhang, C, Solomon, C. G., Manson, J. E., & Hu, F. B. (2006). A prospective study of pregravid physical activity and sedentary behavior in relation to risk for gestational diabetes mellitus. *Arch Intern Med, 166,* (5), 543-548.

Zhang, G., & Wang, Y. (2004). Trends in the association between obesity and socioeconomic status in US adults. 1971-2000. *Obes Res. 12*(10): 1622-32.

Zera, C., McGirre, S., & Oken, E. (2011). Screening for obesity in reproductive-aged women. (2011). *Center for Disease Control and Prevention, 8*(6), A125.

Understanding the Concept of Gestational Weight

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MANUSCRIPT #1

UNDERSTANDING THE CONCEPT OF GESTATIONAL WEIGHT

Pregnancy weight gain or gestational weight gain (GWG) can have profound effects on a woman and her fetus. Pre-pregnancy body mass index (BMI) and GWG are important predictors of pregnancy outcomes and fetal growth and development. The patterns of weight gain during pregnancy affect short- and long-term maternal and infant health. A woman's pre-pregnancy BMI modifies the relationship between GWG and infant birth weight (Nohr et al., 2008). This paper will address the concept analysis of gestational weight. Concept analyses are often the focal point of theory building because they can outline problems of a phenomenon in clinical practice (Walker & Avant, 2011).

Obesity and GWG

Infants of obese women, particularly women with higher GWG, are more likely to be large for gestational age (LGA), experience birth injury, have increased adiposity and insulin resistance, and be at risk for obesity, high blood pressure and Type 2 diabetes (Catalano, Presley, Minium, & Hauguel-de-Mouzon, 2009). Increased GWG can further perpetuate the cycle of obesity, which has reached epidemic proportions in the United States.

The most common reason for rapid increase in weight among women of childbearing age is excessive gestational weight gain. (Wang & Beydoun, 2007). Obesity and excessive weight gain during pregnancy are associated with greater use of healthcare services, longer hospital stays, and increased healthcare costs according to a study by the Centers for Disease Control and Prevention (CDC) and Kaiser Permanente (CDC, 2008).

On the other end of GWG, inadequate weight gain in pregnancy, particularly low or normal pre-pregnancy weight, is associated with higher rates of prematurity, low birth weight, newborns that are small for gestational age (SGA), and higher rates of infant morbidity and mortality (Rasmussen, Catalano, & Yaktine, 2009). In 1970, the National Academy of Sciences Committee on Maternal Nutrition concluded that women should not attempt to restrict normal weight gain during pregnancy. The report linked dietary restrictions to low birth weight with adverse effects on the fetus and newborn (Institute of Medicine [IOM], 1990; 2009). As a result of this report, the Committee on Maternal Nutrition discussed the need for weight gain recommendations during pregnancy. After numerous studies on GWG, the IOM formally addressed gestational weight guidelines in 1990. Excessive gestational weight gain occurs when a woman exceeds the recommended guidelines and conversely, inadequate gestational weight occurs when a woman's pregnancy weight gain falls below the guidelines published in 1990 and revised in 2009 (Rasmussen & Yatkine, 2009).

Prior to the release of the IOM's 2009 report, *Weight Gain During Pregnancy: Reexamining the Guidelines,* numerous research studies were revisited and interventional studies were conducted on the topic of gestational weight gain. Despite these noted

research studies, managing GWG remains a challenge for healthcare providers (Gillman, 2012). This highlighted the need for a concept analysis on gestational weight.

Aims of Analysis

Concept analysis helps to communicate understanding about a phenomenon and later find ways to measure the concept by generating defining attributes, identifying antecedents, consequences, and empirical referents, and by constructing model, borderline, related, and contrary cases as discussed by Walker and Avant (2011). The primary aim of this concept analysis paper is to clarify the meaning and refine the concept of gestational weight by developing a working definition to help healthcare providers identify and manage gestational weight. An additional aim is to distinguish between the normal, ordinary, and scientific language of this concept. First, the researcher will address the concept uses based on literature reviews.

Concept Uses

The concept uses of gestational weight will provide precise operational definitions that by their very nature have construct validity (Walker & Avant, 2011). The words *gestation* and *weight* will be defined separately, and then *gestational weight* will be defined as one term with dictionary terminologies and other disciplines' usage by reviewing the literature.

Gestation

The word *gestation* is of Latin origin (*Gestatio* from *gestare*), meaning "to bear," and its first known use was in 1615 (Merriam Webster Online, 2012). Gestation is the age of a fetus or newborn; it is usually expressed in weeks dating from the first day of the mother's last menstrual cycle and spans for about nine months. The number nine is a

favorable number associated with eternity, and it represents a complete cycle of growth. The biblical number nine is sacred, signifying the number for man, and depicts gestation, which is for a period of nine months (AstroVera, 2014). As used by the Greeks, *gestation* is the period of conception to birth and defined this as the entire gestation process (Church of the Great God, 2014).

According to the American Heritage Dictionary Online (2014), the scientific definition of *gestation* is the period of fetal development in the uterus from conception until birth. This dictionary further relates gestation to the conception and development of a plan. Gestation is the process of evolution, fecundation, gravidity, growth, incubation, maturation, pregnancy, and ripening (Dictionary.com, 2013). Other descriptions of gestation include the carrying of the young in the uterus and conception and development, especially in the mind (e.g., "the gestation of new ideas" or "the book has been in gestation for a long time"; Merriam Webster Online, 2014). *Pregnancy* and *gestation* are used as synonyms both in the scientific and lay terms.

Weight

Weight is defined as a body's relative mass or the quantity of matter contained by it giving rise to a downward force, and the heaviness of a person or thing (Dictionary.com, 2013). In the physics sense, weight is "the amount or quantity of heaviness or mass; the force that gravitation exerts upon the body," used as a power entity such as in the phrase, "to throw one's weight around" (Dictionary.com, 2013). Synonyms such as *effect, power, efficacy, import, significance, encumber, saddle*, and *load* are often used for *weight* (Dictionary.com, 2013). Excessive fat, corpulence, oppressiveness or pressure are other definitions, and the term is used in statistics to assign

power to the effect size (Freedictionary.com, 2012). Dictionary references for gestation and weight vary slightly depending on usage and a specific discipline's use of the word.

Gestational Weight

A search of dictionaries and the literature using various databases such as CINAHL and Google Scholar yielded limited definitions of *gestational weight.* Moreover, the term shows more of an association to predictors and outcomes than specific definitions in the literature. Gestational weight is defined as the pregnant woman and her weight gain during the pregnancy (Perry, Hockenberry, Lowdermilk, Wilson, 2009). There is no other specific definition offered, but the term is associated to pre-pregnancy BMI and maternal and fetal outcomes based on the amount of weight gain during pregnancy.

During pregnancy, insufficient or excessive gestational weight gain can compromise the health of the mother and fetus. All women are encouraged to choose a healthy diet regardless of pre-pregnancy weight. Exercises such as walking and swimming are recommended for healthy pregnancies. Exercise has notable health benefits for both mother and baby, including prevention of excessive GWG (Poirier et al., 2006). According to Ota et al. (2010), low pre-pregnancy BMI and suboptimal GWG during pregnancy are associated with risk factors including SGA delivery, preterm birth, and intrauterine growth restriction. These complications are predictors for neonatal mortality and morbidity. Furthermore, increasing GWG of obese women during pregnancy is associated with increased risk for pregnancy complications such as gestational diabetes, hypertension, caesarean delivery, and increased infant birth weight (Jensen et al., 2005).

A number of studies have suggested setting guidelines for GWG with close monitoring of nutritional intake and physical activity and emphasized pre-pregnancy BMI and cultural attributes (Misra, Wasir & Vikram, 2005; Olson, 2008; Warren, Rance, & Hunter, 2012). Adhering to the 2009 IOM guidelines for gestational weight gain by monitoring physical activity and caloric intake is known to decrease the prevalence of pregnancy complications; however, studies have shown physical activity and proper dietary intake are not always adequately addressed by healthcare providers (Evenson, Moos, Carrier, & Siega-Riz, 2009; Sarwer, Allison, Gibbons, Tuttman-Markowitz & Nelson, 2006; Yeo, Cisewski, Lock, & Marron, 2010). A diet of foods high in fat and sugars accompanied by sedentary lifestyle can lead to increased GWG and long-term obesity for women (Warren et al., 2012).

Defining Attributes

After examining the structure and function of the concept of gestational weight and a review of the dictionary and literature, defining attributes can be identified. The main themes expressed are consequences of excessive and inadequate growth and the influences of dietary intake and physical activity. Based on this reasoning, the critical defining attributes that are commonly noted and will be used by this researcher for this concept analysis are *growing, maternal dietary intake*, and *physical activity*. These were chosen based on Walker and Avant's (2011) suggestion that the researcher choose attributes that differentiate the concept of interest from other concepts. These attributes of gestational weight are related in that they are critical to promoting adequate GW to minimize problems for women and newborns (Figure 4).

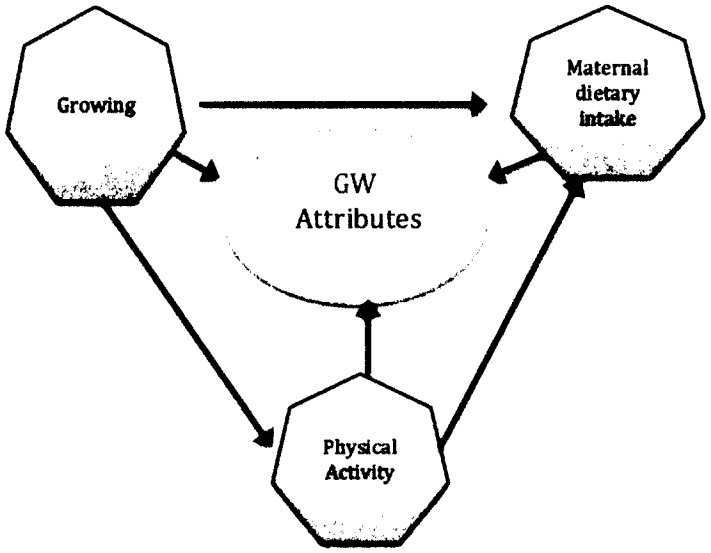

Figure 4. Defining attributes.

Growing

The defining terms of gestational weight that are considered when discussing the attribute of growing are: 1) growth of the uterus and fetus in terms of gestational age in week and fundal height measurement, 2) growth from conception to delivery of the newborn, 3) level of weight gain (appropriate, inadequate, or excessive), and 4) mother's weight gain and newborn's birth weight.

Maternal Dietary Intake

Key elements of maternal dietary intake first address expected gestational weight gain based on a woman's pre-pregnancy BMI. For example, a woman who is underweight (BMI <18.5 kg/m^2) should gain 28-40 pounds, while a woman who is of normal weight (BMI >18.5-24.9 kg/m^2) should gain 25-35 pounds. A woman who is overweight (BMI > 25- 29.9 kg/m^2) should gain 15-25 pounds, and a woman who is obese (BMI > 30.0 kg/m^2) should only gain 11-20 pounds during pregnancy (Rasmussen

& Yaktine, 2009). Based on a woman's pre-pregnancy BMI, she should be counseled on the amount of added caloric intake per day throughout the pregnancy. A woman with a normal BMI, for example, should add 300 more calories per day (Anderson, Ebrahim, Floyd, & Atrash, 2006). It is important that healthcare providers give ongoing support to help women stay within the recommended GWG ranges.

Maternal Physical Activity

The question of how much physical activity a pregnant woman should engage in continues to be an area of strong debate. Wadsworth (2007) reports that many pregnant women do not exercise and recommends that moderate exercise be advised for pregnant women and included as part of their prenatal care; however, this is not always adequately addressed by providers. It is recognized that exercise has benefits for both the mother and fetus. When a woman becomes pregnant, the current advice for women who were physically active prior to pregnancy is to continue their current level of activity. Women who are not physically active should engage in regular low impact physical activity.

In 2008, the American College of Gynecology (ACOG) released recommendations for physical activity during pregnancy. They recommended women participate in 2 hours and 30 minutes of moderate aerobic exercise per week (HHS, 2008). Healthcare providers need to work with women to meet the IOM GWG guidelines by addressing the ACOG physical activity guidelines.

Cases will be constructed based on these defining attributes, and the model case will include all the defining attributes under study (growing, maternal dietary intake, and physical activity), while the borderline case will contain most but not all the attributes. A related case will be discussed to address the concept of gestational weight but will not

contain the critical attributes. Lastly, the contrary case will not include the actual concept of gestational weight (Walker & Avant, 2011).

Model Case

L. L. is 32 weeks pregnant and is concerned about gaining too much weight during her pregnancy. She works out 4 times per week for 45 minutes and eats well-balanced meals to ensure that she is getting the additional 300 calories per day during the pregnancy. She has BMI of 22 kg/m^2 and intends to gain a total of 25 pounds. During her scheduled prenatal visit, her fundal height and weight gain are measured and are appropriate for her current gestational age.

Analysis

This model case illustrates all the defining attributes, maternal dietary intake, growing, and physical activity (Figure 5).

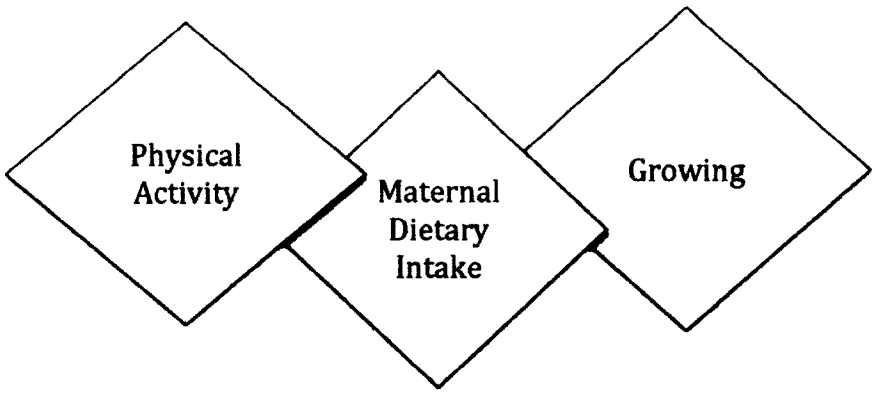

Figure 5. Model case.

L. L. is concerned about gaining too much weight but her fundal height and weight gain are appropriate for gestational age and thus the attribute of growing is addressed. Her additional intake of 300 calories per day is appropriate based on her BMI, which is within the normal range, and she is adhering to the physical activity

recommended guidelines of at least 2 hours 30 minutes of exercise per week; thus, physical activity and dietary intake are present in this case.

Borderline Case

K. M is 28 years old and is 30 weeks pregnant. A nurse compares K.M.'s current weight to her last prenatal visit and realized she has exceeded the expected weight gain requirements for current weeks' gestation. The nurse midwife asks K. M. to document her food intake for the past 24 hours. K. M. states, "I eat a lot throughout the day because I feel the need to eat for two." The nurse midwife recognizes the need for some education regarding dietary intake and refers her to the clinic's dietitian.

Analysis

Most of the elements of the defining attributes of gestational weight are present in this case—maternal dietary intake and growing (Figure 6).

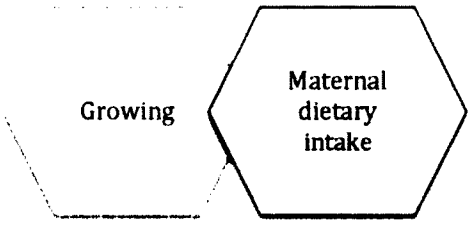

Figure 6. Borderline case.

Based on the assessment finding, K. M.'s caloric intake exceeds the recommended daily allowance, and she is gaining too much weight. Therefore, excess growth and caloric intake are noted. There is no mention of any exercise regimen and as such, the defining attribute of physical activity is missing from this case.

Related Case

S. S. is a 51-year old woman who has experienced infrequent menses for the past 6 months, an unusual occurrence for her. Before that time, her menses had been regular. She noticed she has been gaining more weight even though she has not made any lifestyle changes. She is later diagnosed as entering the period of perimenopause.

Analysis

S. S.'s situation is somewhat related to the concept, as it centers on a woman's menstrual cycle and weight gain; therefore, growing is addressed. However, her case does not contain all the defining attributes related to gestational weight.

Contrary Case

D. A. complains of changes to her abdominal contour and pain. She is also experiencing nausea and vomiting. She suspects she is pregnant and visits her doctor. Examination and ultrasound reveal a questionable abdominal tumor.

Analysis

D. A.'s case meets none of the defining attributes pertinent to the concept under study (Walker & Avant, 2011). Her abdominal contour, pain, nausea, and vomiting are not related to concept gestational weight but rather an abdominal mass.

Antecedents and Consequences

Antecedents are events or incidents that must be present for the concept to occur (Walker & Avant, 2011). The antecedents for gestational weight are conception, pre-pregnancy BMI, a woman's prior demographic and health status, and fetal exposure (Figure 7).

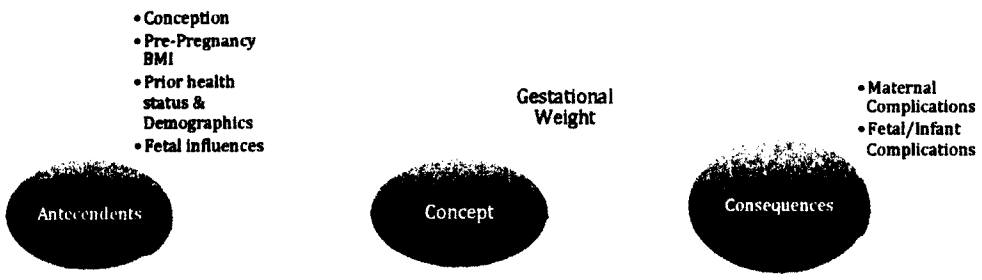

Figure 7. Antecedents and consequences.

Conception is the fertilization of the ovum and the sperm in the fallopian tube that marks the beginning of the pregnancy. During pregnancy, a woman will gain weight due to normal changes such as the growing fetus, amniotic fluid, placenta, additional caloric intake, and lack of exercise. However, other maternal factors can influence GWG patterns, as discussed throughout this paper. Healthcare providers should be aware of a woman's pre-pregnancy BMI and base the recommended gestational weight gain on this fact. They should also monitor the course of the pregnancy, recognizing problematic influences that can affect maternal and fetal well-being. Lastly, healthcare providers should prioritize the addressing of dietary recommendations and physical activity guidelines through effective education during the antenatal period to reduce adverse outcomes.

Unlike antecedents, consequences are outcomes or events that happen as a result of gestational weight, including pregnancy outcomes such as maternal and fetal/infant complications. Specific maternal and fetal/infant complications could depend on a woman's prior health status, possible insults to the fetus in utero, and influences of the woman's modifiable behaviors during pregnancy, resulting in inadequate or excessive

GWG patterns. Precipitating events leading to inadequate GWG might include iron deficiency anemia, eating disorders, hyperemesis gravidarium, and teen pregnancy (Anderson et al., 2006; Fernando & Viteri, n.d.). Infant complications associated with inadequate GWG include pre-term birth, SGA birth, intrauterine growth restriction, and infant mortality (Han et al., 2011).

On the other hand, prior factors contributing to excessive GW are BMIs above the normal range, poor diet, and lack of exercise. Excessive GWG can lead to gestational diabetes and increase a woman's risk of developing type 2 diabetes within 5 years after delivery and increase the rate of caesarean sections, potentially life-threatening preeclampsia, and lifelong obesity (Stotland et al., 2005). Children whose mothers gained more than the IOM-recommended weight and were overweight prior to becoming pregnant are at increased risk for large birth weight, or large for gestational age newborn, and the possibility of childhood obesity (Stotland et al., 2005). Consequences are useful in determining variables and neglected ideas and are helpful in that they can provide directions for research ideas relating to the concept being analyzed (Walker & Avant, 2011).

Empirical Referents

Identifying the empirical referents is the final stage of concept analysis. Empirical referents are categories that display the occurrence of the concept and help to define the attributes (Walker & Avant, 2011). The empirical referents of the phenomenon gestational weight identified by this researcher are maternal exercise, maternal complications, maternal weight gain, caloric intake, newborn birth weight, and fetal/infant complications (Figure 8). The identification of these empirical referents

shows associations between them and the defining attributes of the concept of gestational weight and could lead to instrument development.

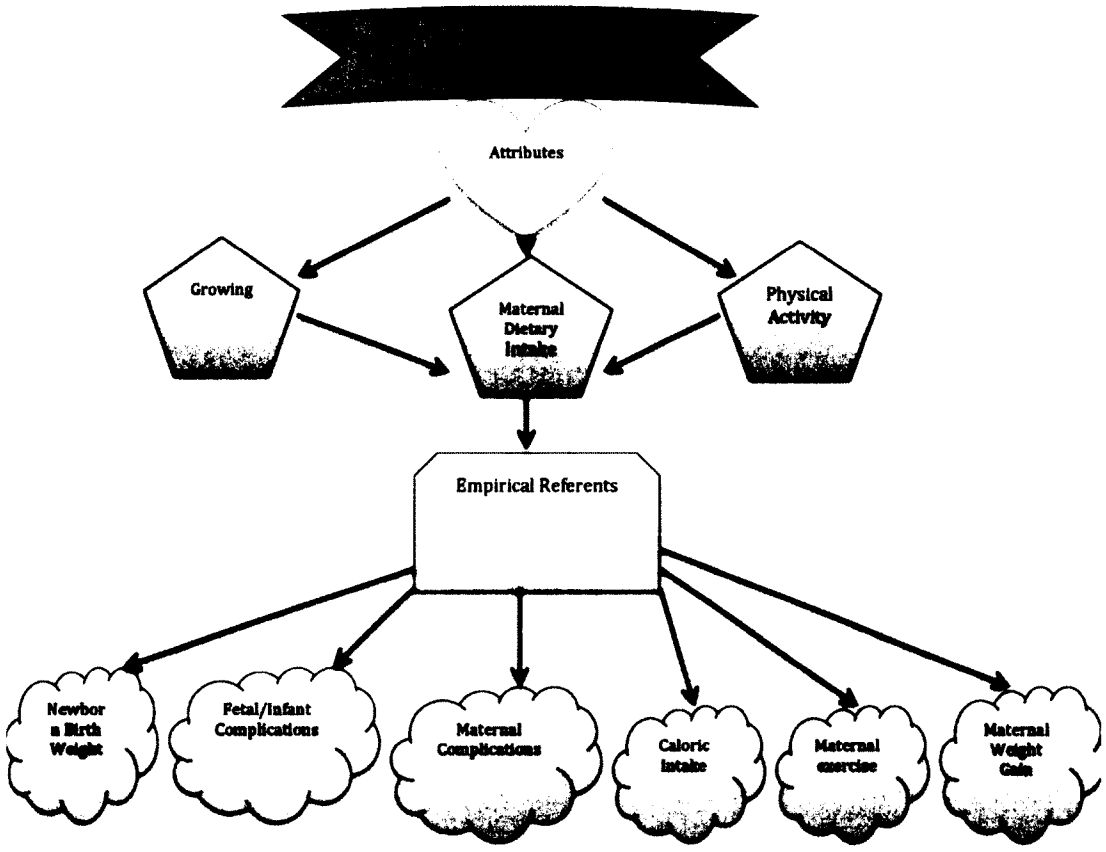

Figure 8. Concept analysis of gestational weight.

Anticipated Uses

Since this concept analysis is in its preliminary stage, the next step is to use the attributes and empirical referents to develop operational definitions for the terms used throughout this paper and link them to gestational weight. Eventually, the plan could be to refine and develop instruments to measure the variables that will be used in future research when studying the concept of gestational weight.

Summary

Gestational weight was selected for this concept analysis because it has been recognized as an important factor that must be considered when working with women of childbearing age who are considering pregnancy. The underpinnings of this concept analysis elucidated its uses. Literature reviewed presented evidence of the detrimental effects of inadequate and excessive gestational weight gain patterns on women and their children. However, the management of GW seems to be an ongoing problem and it is the desire of this researcher to help nurses and other healthcare providers gain a better understanding of this concept in order to develop appropriate interventions and implement programs and policies to improve outcomes for women and children. Ultimately, more work on defining the concept of gestational weight could lead to the advancement of a theoretical base through an iterative process of testing, retesting, and restating.

References

American Heritage Dictionary Online (2014). Gestation. Retrieved from www.americanheritage.com/gestation

Anderson, J. E., Ebrahim, S., Floyd, L., & Atrash, H. (2006). Prevalence of risk factors for adverse pregnancy outcomes during pregnancy and the preconception period-United States, 2002-2004. *Maternal Child Health Journal, 10*(s), 101-106. doi: 10.007/s10995-006-0093-z

AstroVera (2014). The bible numerology code number 9. Retrieved from http://www.astrovera.com/bible-religion/190-bible-number-9.html

Church of the Great God (2014). Bible verses about spiritual rebirth. Retrieved from http://www.bibletools.org/index.cfm/fuseaction/Topical.show/RTD/cgg/ID/14148/Spiritual-Rebirth.htm#ixzz2AcRSoMXR

Catalano, P. M., Presley, L., Minium, J., & Hauguel-de-Mouzon, S. (2009). Fetuses of obese mothers develop insulin resistance in utero. *Diabetes Care, 32*(6), 1076-1080.

Centers for Disease Control and Prevention (CDC). (2008). Pregnant women who are obese linked with greater health care services use, also have longer hospital stays. Retrieved from http://www.cdc.gov/media/pressrel/2008/r080402.htm

Dictionary.com (2012). Weight. Retrieved from www.dictionary.reference.com/weight

Evenson, K.R., Moos, M. K., Carrier, K., & Siega-Riz, A. M. (2009). Perceived barriers to physical activity among pregnant women. *Maternal Child Health Journal 13*(3), 364-375.

Fernando, E., & Viteri, M.D. (n.d.). The consequences of iron deficiency and anaemia pregnancy on maternal health, the foetus and the infant. Retrieved from www.unsystem.org

Flegal, K. M., Carroll, D. M., Ogden, C. L., & Curtin, L.R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *Journal of the American Medical Association, 303*(3), 235-241.

Free Dictionary.com (2012). Gestation, weight. Retrieved from www.thefreedictionary.com/

Gillman, M. W. (2012). Gestational weight gain: Now and the future. *Circulation 125*, 1339-1340. doi: 10.1161/CIRCULATIONAHA.112.091751

Han, Z., Lutsiv, O., Mulla, S., Rosen, A., Beyene, J., & McDonald, S. D. (2011). Low gestational weight gain and the risk of preterm birth and low birthweight: A systematic review and meta-analyses. *ACTA Obstetricia et Gynecologica 90*, 935-954.

Healthy People 2020. (2014). Maternal, infant, and child health. U.S. Department of Health and Human Services. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=26

HHS. (2008). Physical activity guidelines for Americans. Retrieved from: http://www.health.gov/PAGUIDELINES/

Institute of Medicine (IOM). (2009). Weight gain during pregnancy: Reexamining the guidelines (Resources Sheet). Washington, DC: National Academies Press.

Institute of Medicine (IOM). (1990). Nutrition during pregnancy, part 1: Weight gain. Part 11: Nutrient supplements. Washington, DC: National Academies Press.

Jensen, D. M., Ovesen, P., Beck-Nielsen, H., Molsted-Pedersen, L., Sorensen, B., Vinter, C., & Damm, P. (2005). Gestational weight gain and pregnancy outcomes in 481 obese glucose-tolerant women. *Diabetes Care 28*(9), 2118-2122. doi: 10.2337/diacare.28.9.2118

Merriam-Webster Online (2014). Gestation. Retrieved from www.merriam-webster.com/gestation

Misra, A., Wasir, J. S., & Vikram, N.K. (2005). Waist circumference criteria for the diagnosis of abdominal obesity are not applicable uniformly to all populations and ethnic groups. *Nutrition, 21,* 969-976.

Nohr, E. A., Vaeth, M., Baker, J. L., Sorensen, T., Olsen, J., & Rasmussen, K. (2008). Continued associations of pre-pregnant BMI and gestational weight gain with the outcomes of pregnancy. *American Journal of Clinical Nutrition 87*(6), 1750-1759.

Ogden, C. L., Carroll, M. D., & Curtin L. R. (2006). Prevalence of overweight and obesity in the United States, 1999–2004. *Journal of the American Medical Association, 295*(13), 1549–1555.

Oken, E. (2009). Maternal and child obesity: The causal link. *American Journal of Obstetrics and Gynecology, 36*(2), 361-377.

Olson, C. M. (2008). Achieving a healthy weight gain during pregnancy. Reviews of the literature on experimental studies that are designed to help women gain within the guidelines during pregnancy. *Annual Review of Nutrition, 28*, 411-423.

Ota, E., Megumi, H., Suzuki, M., Anh, D. D., Tho, L. H., & Tam, T.T. (2011). Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. *World Health Organization 89*, 127-136. doi: 10.2471/BLT.10.077982

Perry, S. E., Hockenberry, M. J., Lowdermilk, D. L., & Wilson, D. (2009). *Maternal child nursing care.* (4th ed.). Maryland, Heights, MO: Mosby, Elsevier.

Poirier, P., Giles, T.D., Bray, G.A., Hong, Y., Stern, J.S., Pi-Sunyer, F.X., Exkel, R.H. (2006). Obesity and cardiovascular disease: Pathophysiology, evaluation, and effect of weight loss: An update of the 1997 American heart association scientific statement on obesity and heart disease from the obesity committee of the council on nutrition, physical activity, and metabolism. *Circulation, 113*, 898-918.

Rasmussen, K. M., & Yaktine, A. L. (Eds.). (2009). Weight gain during pregnancy: Reexamining the guidelines. Washington, DC: National Academy Press.

Rasmussen, K. M., Catalano, P. M., & Yaktine, A. L. (2009). New guidelines for weight gain during pregnancy: What obstetrician/gynecologists should know. *Current Opinion Obstetrics Gynecology, 21.* doi:10.1097/GCO.0b013c328332d24e.

Sarwer, D. B., Allison, K. C., Gibbons, L. M., Tuttman-Markowitz, J., & Nelson, D. B. (2006). Pregnancy and obesity: A review and agenda for future research. *Journal of Women's Health, 15*, 720-733.

Stotland, N. E., Haas, J. S., Brawarsky, P., Jackson, R. A., Fuentes-Afflick, E., & Escobar, G. J. (2005). Body mass index, provider advice, and target gestational weight gain. *Obstetrics and Gynecology 105,* 633-638.

Thesaurus.com (2012). Gestation. Retrieved from www.thesaurus.com/gestation

Wadsworth, P. (2007). The benefits of exercise in pregnancy. *The Journal for Nurse Practitioners* (5), 333–339. doi:10.1016/j.nurpra.2007.03.002

Walker, L. O., & Avant, K. C. (2011). *Strategies for theory construction in nursing.* (5th ed). Upper Saddle River, NJ: Pearson Prentice Hall.

Wang, Y., & Beydoun, M. A. (2007). The obesity epidemic in the United States: Gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiology Review 29*, 6-28.

Warren, L., Rance, J., & Hunter, B., (2012). Feasibility and acceptability of a midwife-led intervention programme called "Eat well, keep active" to encourage a healthy lifestyle in pregnancy. *BioMed Central Pregnancy and Childbirth 12*(27). Retrieved from http://www.biomedcentral.com/1471-2393/12/27

Yeo, S., Cisewski, J., Lock, E. F., & Marron, J. S. (2010). Exploratory analysis of exercise adherence patterns with sedentary pregnant women. *Nursing Research, 59*(4), 280-287.

Mothers' Characteristics and Gestational Weight Gain Patterns

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MOTHERS' CHARACTERISTICS AND GESTATIONAL WEIGHT GAIN PATTERNS

Abstract

Background: Managing maternal gestational weight gain (GWG) remains a global health priority (Healthy People 2020, 2014). The prevalence of obesity among women of childbearing age, 15-44 years of age, is alarming and expected to continue (Zera, McGirr, & Oken, 2011). An estimated 27% of women of childbearing age fall into the obese category and 8% are in the extreme obese category with body mass index (BMI) greater than or equal to 40 kg/m^2 (Rasmussen & Yaktine, 2009). These women are at increased risk of gaining excessive weight during the perinatal period predisposing them to complications, for instance hypertensive disorders, gestational diabetes, preterm births, increased rates of cesarean births, and a link to lifelong obesity in the woman and her children (Flegal, Carroll, Ogden, & Curtin, 2010). Institute of Medicine (IOM) recommendations for GWG were revised in 2009 with the inclusion of a stricter GWG range for obese women (11-20 lbs.) compared to the original 1990 recommendation of at least 15 lb. Studies are needed to assess whether these guidelines are being followed.

Purpose: The purpose of this study was to examine GWG patterns among a group of racially, ethnically, economically diverse women. The specific aim is to describe the GWG patterns and characteristics of women who gain above, within, or below the 2009 IOM GWG recommended guidelines based on pre-pregnancy BMI.

Methods: A descriptive, correlational, cross-sectional design using retrospective data abstracted from medical records was used. A purposive sample of all women (N = 4500) who gave birth between January 1, 2011 and December 31, 2012 at a large multi-

community hospital healthcare system in San Diego County provided data for this study. Inclusion criteria: singleton live birth, data on pre pregnancy BMI & GWG, ≥ 4 prenatal visits, and delivered at ≥ 37 weeks gestation. Parametric and non-parametric statistics were used including descriptive statistics, correlations, and Chi-square, to assess characteristics of the sample and examine relationships between the variables.

Results: Two hundred ninety women met inclusion criteria. Pre-pregnancy BMI categories were underweight (6), normal 153 (51.90%), overweight 102 (34.50%), and obese 40 (13.70%); 30.80% gained within, 18.00% gained below, and 51.20% exceeded the recommended weight gain range; more than two-thirds did not meet the GWG recommendations. Regardless of race, age, parity, marital status, primary language, type of medical insurance, 69.20% of the women did not adhere to the recommendations.

Implications: Findings from this study show in this sample, women were not adhering to the 2009 IOM GWG recommendations, Further research is needed to obtain the mothers' perspectives on why they are not adhering to the recommendations.

Introduction

Extant studies have linked excessive gestational weight gain (GWG) to obesity rates in the United States (Rasmussen, Catalano, & Yaktine, 2009). The average woman gains more weight than recommended during pregnancy and excessive GWG has been linked to adverse outcomes including obesity, cardiovascular disease, hypertension, diabetes, higher rates of cesarean deliveries for the woman, preterm births, small or large for gestational age birth weight, and a link to lifelong obesity in the woman and her child (Flegal, Carroll, Ogden, & Curtin 2010; Rahman & Berenson, 2012; Sarwer, Allison, Gibbons, Tuttman-Markowitz, & Nelson, 2006). Notably, women who were overweight and obese prior to pregnancy were 2-6 times more likely to exceed weight gain guidelines than women of normal BMI (Brawarsky et al., 2005; Chasan-Taber, Schmidt, Pekow, Sternfeld, Solomon, & Markenson, 2008).

Managing GWG remains a global health priority (Healthy People 2020, 2014). The Institute of Medicine's (IOM) recommendations for GWG were revised in 2009 with the inclusion of a stricter GWG range for obese women (11-20 lbs.) than the original 1990 recommendation of at least 15 lb. Studies are needed to assess whether these guidelines are being recommended and followed. A better understanding of these patterns could help clinicians tailor interventions for the successful management of GWG. Thus, the purpose of this study was to examine GWG patterns among a group of racially, ethnically, economically diverse women. The specific aim was to describe the GWG patterns and characteristics of women who gain above, within, or below the 2009 IOM GWG recommended guidelines based on pre-pregnancy BMI.

Theoretical Framework

Health Promotion Model (HPM)

This study is guided by Pender's (1996) Health Promotion Model (HPM), created to explain and predict health-promoting components of lifestyle and emphasize the relationship between person (patient characteristics) and environment (interpersonal/ situational influences). In this study, patient characteristics include pre-pregnancy BMI, age, race/ethnicity, and parity. Interpersonal influences include socioeconomic status (i.e. private insurance and government-funded insurance) and healthcare provider type (certified nurse midwife [CNM] or obstetrician [MD]). HPM provides a mechanism to identify sociodemographic, interpersonal, and personal characteristics associated with GWG patterns.

Methods

Research Design, Sample, and Sampling

A retrospective cohort design was used for this study. Participants were selected from all women (N = 4,500) who gave birth between January 1, 2011 and December 31, 2012 at a large multi-community hospital healthcare system located in San Diego County; 1,397 mothers delivered singleton babies and of these 621 cases were randomly selected. From the 621 cases, 83 were missing pre-pregnancy BMI or GWG information, 103 had less than 4 prenatal visits, 19 had gestational age less than 37 weeks, and 115 were missing other important study variables; 301 met the inclusion criteria: women carrying singleton pregnancies, live births, ≥ 4 prenatal visits, gestational age $\geq$37 weeks, and pre-pregnant BMIs.

Data for the analyses reported here were abstracted from Labor and Delivery electronic medical records (L&D EMRs) and the hospitals' postpartum computerized charting system; the L&D EMR did not communicate with the postpartum computerized system; thus, data was abstracted both electronically and manually. All study procedures were reviewed and approved by the appropriate institutional review boards and administrators. Since the data was collected retrospectively, there was no patient contact that involved any risk. Precautions were taken to protect patient privacy in accordance with the Health Insurance Portability and Accountability Act (HIPAA); data were stored on a secured computer and de-identified prior to transferring the database for statistical analysis.

Measures

Pre-pregnant body mass index. Pre-pregnant height and weight were recorded from prenatal records scanned into the L&D records. Pre-pregnancy weight and height were obtained through one of two sources: 1) self-report of pre-pregnancy weight and height at the first prenatal visit as recorded on the prenatal record or 2) measured weight and height at first prenatal visit between 6- 8 weeks gestation as recorded on prenatal record. Pre-pregnant body mass index (kilogram/(meter) ^{2}) or (pounds/(inches)^2 x 702) was calculated from weight and height recorded in the L&D EMR and was categorized based on the 2009 IOM guidelines as dictated by the World Health Organization (WHO) BMI criteria.

Gestational weight was estimated through either 1) self-report of current weight at the time of admission for delivery or 2) documented weight at the last prenatal visit within one week of delivery. Gestational weight gain was defined as the difference

between the maternal weight measured within one week prior to delivery or self-reported current admission weight and the maternal weight recorded at the first prenatal visit or self-reported at the first prenatal visit. The weight values from the selected sources were entered into the L&D EMR by the labor and delivery nursing staff when the patient arrived to the labor and delivery units. Gestational weight gain was categorized according to the 2009 IOM GWG guidelines (below, within, or exceed recommendations),

Data on maternal age at visit, marital status, race/ethnicity, primary language, parity, weeks gestation, healthcare provider (MD or CNM), type of medical insurance, smoking status, alcohol intake, and illicit drug use were also abstracted. Maternal age at delivery is defined as the age recorded on the delivery record. Marital status, race/ethnicity, and primary language were obtained from the admission record at the time of delivery. Parity is defined as the number of prior deliveries after 20 weeks gestation. Gestational age (GA) was obtained from the prenatal record and calculated based on the first day of the last menstrual period to time of delivery or early ultrasound to obtain accurate due date. Medical coverage to identify the woman's socioeconomic (SES) status was grouped as private insurance (including military) or government insurance and was obtained from the EMR.

Following completion of data management, preliminary analyses included descriptive statistics of the key variables; upon review, 6 cases with a pre-pregnant underweight BMI (<18.5), smoking, alcohol intake, and illicit drug use were excluded due to small cell sizes. Descriptive statistics including frequencies and chi square analyses were performed on the 295 remaining cases. GWG adherence was identified and sociodemographic characteristics were examined. Statistical analyses were presented as

mean, +/- standard deviation (SD), and chi-square. All analyses were conducted using Statistical Package for the Social Sciences (SPSS) version 22.0.

Results

Mothers' ages ranged from 15 to 48 years, with a mean age of 28.08 (SD=5.98). When categorized into *less than 18 years old, 18-34,* and *greater than or equal to 35 years of age*, a majority of women in the sample (247 cases or 85.9%) were between 18 and 34 years, the optimal age range for childbearing in terms of low-risk age groups. The sample was racially/ethnically diverse with 143 (48.5%) women identifying as White, 113 (38.3%) as Latina, and 39 (13.2%) as "Other" ethnic or racial group (to include Asians, African Americans, and American Indians). More than half (n = 173, 58.6%) were married, 114 (38.6%) were single, and 8 (2.7%) reported some other relationship status such as domestic partner or divorced. With respect to primary language, 218 (73.9%) of patient cases spoke English as their primary language, 72 (24.4%) were Spanish speaking, and 5 spoke another language other than English and Spanish. All women in the study group had medical insurance with slightly more having private insurance including military (153 or 51.9%) compared to government-funded insurance (i.e. Medi-Cal), which often indicates lower SES (142 or 48.1%) and was used as a proxy for SES. For healthcare provider, the women in this study were 6.5 times more likely to have an MD (85.4%) than a certified nurse midwife (CNM) 14.6%. Gestational age in weeks ranged from 37.00 to 41.60 weeks with a mean of 39.24 (SD=1.03) weeks (see Table 4).

Slightly more than half of the patients 153 (51.90%) had a pre-pregnancy BMI in the normal range, 102 (34.5%) were in the overweight BMI range, and 40 (13.7%)

were in the obese BMI range. Fifty-three (18.0%) gained below the recommended GW, 91 (30.8%) gained within recommended GW, and 151 (51.2%) exceeded the recommended GWG guidelines (see Table 4).

To examine the pattern of gestational weight gain based on pre-pregnancy BMI categories, pre-pregnant BMI categories were stratified by amount of weight gain by categories within, below, and exceeding GWG (Table 6). Statistically significant differences were found χ^2 (4) = 13.12, p = 0.01. Sixty one percent (n = 56) of women who had a normal pre-pregnancy BMI gained the recommended GWG, 29 (32.2%) of overweight, and 6 (6.7%) obese BMIs gained the recommended GWG. For women who gain below the recommended GWG pre-pregnancy BMI categories are as follows: 33 (62.3%) normal, 14 (26.4%) overweight and 6 (11.3%) in the obese category. Approximately 51% (n = 151), exceeded the recommended GWG, based upon pre-pregnancy BMI 64(42.7%) normal, 59 (38.7%) overweight, and 28 (18.7%) obese exceeded recommended GWG (Figure 9 and Table 6).

Pre-pregnancy BMI categories and GWG by race/ethnicity showed no statistically significant differences, χ^2 (4) = 8.50, p = 0.08 (Table 5) and χ^2(4) = 4.44, p = 0.35 (Table 6), respectively. More than half (52.5%) of the women in the pre-pregnancy obese category were White, 35% (n = 14) Latina, and 12.5% Other minorities; Latinas and Whites comprised more than 90% of the overweight pre-pregnancy BMI group and approximately 81% of the normal weight group (see Table 5). For those attaining recommended GWG, 90% were Latinas and Whites; 45% Whites, 35.8% Latinas, and 18.9% Other minorities gained less than and 52% White, 34.7% Latinas, and 13.3% other minorities exceed the recommended GWG (Figure 10 and table 6).

Discussion/Implications

According to this study, women are exceeding the recommendations more often than staying within the recommendations. Furthermore, women with normal pre-pregnancy BMI were often gaining outside the recommended range. The pre-pregnancy BMIs and GWG patterns were similar regardless of race/ethnicity, although pre-pregnancy BMIs trended toward statistical significance ($\chi^2 = 8.50$ (4), $p = 0.08$). Age, parity, marital status, primary language, and gestational age in weeks did not show significant differences in contributing to GWGs outside the IOM recommendations or pre-pregnancy BMIs except for parity which showed statistical significance to pre-pregnancy BMI ($F(2) = 8.13, p = 0.01$).

Other studies have produced mixed results when taking into account medical insurance status-SES, race/ethnicity, and GWG. Chasan-Taber et al. (2008) reported SES was not associated with excessive GWG. Contrary to this, other studies found Hispanic women with government-funded medical insurance was a strong indicator of risk for maternal morbidity such as excessive GWG and obesity; this trend may be due in part to cross cultural differences in norms pertaining to ideal body image, wellness, and financial security (Wang & Beydoun, 2007). The result of this study supports previous studies in type of insurance are not significantly associated with GWG.

In contrast to Flegal, Carroll, Ogden, and Johnson's (2012), findings indicating the prevalence and trend of obesity in 2009-2010 according to race/ethnicity showed 40.7% of Hispanic and 58.6% of Black women were obese compared to 33.4% of White women; this current study found White women had a higher percentage of obesity with

52.5% compared to 35% of Latina women. This study supports all women regardless of race/ethnicity need to be monitored carefully, not just minority groups.

In 2009, 21.2% of women participating in the Pregnancy Nutrition Surveillance System (PNSS) gained inadequate weight and 48.2% gained excessively (CDC, 2009). In this study, 18% gained inadequately while 51.2% gained over the recommended 2009 IOM guidelines. The study further found with 1.3 million low-income women from 31 states, more than 50% of White, American Indian, and multi-race women gained excessively compared to 48% Blacks, 43% Hispanic, and 33% Asian women. In the study reported here 52% of Whites, 34.7% of Latina, and 13.3% of other gained in excess of the guidelines. In previous studies, inadequate GWG was seen among Asian (26.6%) and Hispanic and Black (about 23%) compared to 18.4% of non-Hispanic White women (Headen, Davis, Mujahid, & Abrams, 2012). This was not the case in this current study; 45.3% of White women, 35.8% of Latina women, and 18.9% of Other minority women had below recommended GWG.

Studies published prior to the 2009 IOM revision found little evidence the relationship between GWG and fetal outcomes differ between White and Black women (Bodnar, Hutcheon, Platt, Himes, Simhan, & Abrams, 2011; Savitz, Stein, Siega-Riz, & Herring, 2011). Most studies to date have had insufficient participants to evaluate effectiveness of trial by race/ethnicity. More studies are needed to tailor interventions by race/ethnicity or individualized interventions since some women feel approaching GWG from dietary and physical activity standpoint is not adequate; Black women expressed interest in psychological and spiritual approaches focusing on food choices rather than physical activities and White women indicated they would rather focus on physical

activity (Headen et al., 2012). Cultural practices can interfere with GWG patterns; therefore, further research is needed to include cultural aspects when working with women from racial and ethnically diverse backgrounds.

Healthcare providers must pay attention and provide effective education and interventional approaches to women from all race/ethnicity before and during pregnancy in an effort to help women achieve optimal GWG and to prevent lifelong obesity with all its complications. The women in this sample may be influenced by cultural norms, higher than normal caloric intake, lack of physical activity, providers who lack effective education and surveillance abilities on the topic of weight management, and uneasiness addressing weight issues. Other studies are needed to explore the influences that predispose women regardless of race/ethnicity to becoming obese.

The association of increased parity and risk for obesity has not been consistent in previous studies. Some studies report giving birth to one child compared to never having children could double the risk of high GWG contributing to obesity over 5-10 years (Davis et al., 2009; Gunderson, Quesenberry et al., 2004). Other studies report multiparity, or having at least two children increases the risk for obesity (Magann et al., 2011). A recent study by Davis et al. (2013) found multiparous women with short inter-pregnancy intervals, with or without excessive GWG, had increased risk of obesity after childbirth compared to multiparous women with longer inter-pregnancy intervals. In the study reported here, data on the time between pregnancies was not available. More studies are needed to examine the relationship between parity, GWG, and risk for obesity by looking at the length of the interval between pregnancies.

Other influential factors to consider that could contribute to inappropriate GWG ranges are history of depression, levels of stress, preexisting chronic medical conditions (e.g., diabetes, hypertension, anemia), and lifestyle behaviors including alcohol, drug, and smoking habits. Depression and stress are associated with low GWG but vary by race/ethnicity as stress and depression contribute to low GWG among White women but not Black women; limited data are available for Hispanic women regarding levels of stress and GWG (Brawarsky et al., 2005; Chasen-Taber, Schmidt, Pekow, Sternfeld, Solomon, & Markenson, 2008; Walker, Hoke, & Brown, 2009). According to Howell, Mora, Horowitz, and Leventhal (2005), Latina women have been found to be at higher risk of developing depression; however, they are less likely to seek medical assistance.

After extensive literature reviews, the 2009 IOM committee tasked with revising the 1990 GWG recommendations found the lowest risk of gaining within GWG range were women with normal weight and adverse outcomes were more prevalent in the obese BMI category. Notably, this study showed according to the 2009 GWG guidelines, 42.7% of women in the normal BMI category exceeded the recommended GWG range, which could eventually lead to obesity in these women and perpetuate the cycle of obesity and adverse outcomes. The BMI ranges were updated in the new guidelines to the categories developed by the World Health Organization (WHO) and adopted by the National Heart, Lung, and Blood Institute (NHLBI). The other change to the 2009 GWG was stricter range for obese women (11-20 pounds) than the up to 15 pounds in the 1990 GWG recommendations, resulting from data primarily for women with BMI between 30-34.9 $kg/m^{2.}$ but GWG ranges remained the same for the other pre-pregnancy BMI groups. The recommendation did not take into account women with obesity class II (BMI $\geq$ 35-39.9

kg/m^2) or class III (BMI ≥40 kg/m^2) (IOM, 2009). Given the increase in class II and class III obesity, more studies are needed to determine if there should be stricter GWG guidelines to decrease short-term and long-term adverse maternal and infant outcomes for women entering pregnancy with an obese BMI (Flegal et al., 2010; Rasmussen et al., 2010).

Although obesity screening and treatment are recommended by the US Preventative Services Task Force, 1 in 5 women are still overweight and obese at the time of conception (Zera et al., 2011). Prior to the 2009 IOM GWG guidelines, women who gained within the 1990 IOM GWG guidelines showed an association to minimal postpartum weight retention but the guideline recommendations were criticized as a contributing factor to the obesity epidemic due to high GWG in the BMI categories. Based on the 1990 IOM GWG recommendations, 38% of normal weight, 63% overweight, and 46% of obese women gained more than recommended (IOM, 2009). Notably, this study showed percentages of women based on their pre-pregnancy BMI categories exceeded the GWG recommendations with higher 42.7% in the normal weight, and less in the overweight 38.7%, and obese 18.7% pre-pregnancy BMIs. Subsequently, women in the normal pre-pregnancy BMI are also gaining below the recommended GWG guidelines at a rate of 62.3%. Further study is needed to determine whether women in the overweight and obese pre-pregnancy BMI groups are adhering more to the recommended guidelines than the normal BMIs or whether healthcare providers are not focusing their attention on this group.

Findings from this study argue for healthcare providers to target all BMI groups and not just the obese pre-pregnancy BMI. Based on this study using the revised 2009

IOM GWG recommendations, there was an improvement in the obese category relating to excessive GWG as compared to the IOM/NR 2009 statistics mentioned above, but women with normal BMI are exceeding the recommended GWG range at a high rate. At first glance, one could say the new guidelines might be working for selected pre-pregnancy BMI groups especially obese BMI group; fewer women in the obese group are exceeding GWG recommendations as compared to the IOM/NR report. However, this could be a false indicator and does not answer whether obese women are truly gaining less weight during pregnancy. Under the previous guidelines, a woman would exceed the guidelines if she gained greater than 15 pounds but under the new guidelines a woman can gain as much as 20 pounds and would still be inside the acceptable GWG range. Thus, the question remains whether the 2009 IOM GWG recommended guidelines truly help achieve optimal GWGs and pregnancy outcomes.

Study Limitations

These findings must be interpreted in the light of several limitations to this study: the retrospective design, data abstraction of EMRs, potential coding error, and use of self-reports in documentation. Although previous studies have shown good correspondence between self-reporting and clinically measured pre-pregnancy weight, stating self-reporting is a reliable way of obtaining information from patients, self-reporting may also yield underreporting (Gillum & Sempos, 2005; Oken et al., 2007) and may be less reliable among overweight and obese women from various race/ethnic groups (Hinkle et al., 2012). Some variables that may play a role in GWG were not considered as they were not available or were inconsistently reported (educational attainment, smoking, illicit drug use, alcohol intake, and eating disorders); therefore, the researcher did not include

them in the study. Women may have been reluctant to share their real social history. Sample selection and target population of the hospital limit generalizability since true randomization could not be used. Furthermore, only women who received adequate prenatal care were included in this study; those who did not receive prenatal care, which is another high-risk group, were excluded.

Regardless, taken in this context, study findings are encouraging and provide additional data for healthcare and policy agencies in addressing GWG patterns. Race/ethnicity was found not to be a significant factor in GWG patterns; therefore, it is important to target all racial/ethnic groups and take an individualized approach to improving outcomes. In addition, further research is needed to explore other contributing factors to assist with appropriate interventions for women of childbearing age residing in San Diego County and the US at large.

Conclusion

This study can lay the groundwork for healthcare providers as it is duly noted that although these women received prenatal care, a high percentage were overweight (34.5%) and obese (13.7%) prior to pregnancy and 70% gained outside the recommended GWG range. Clearly women are not adhering to the 2009 IOM GWG recommendations. Data from the past 10 years illustrate most women gain in excess of the recommendations. In today's obesogenic environment, the majority of women are anticipated to have difficulty limiting weight gain to the upper limit of the 2009 IOM guidelines. Therefore, personalized interventions for each woman to improve dietary intake and physical activity and to assess and intervene if psychological counseling is needed are all important measures to help women achieve their targeted weight gains.

Healthcare providers caring for pregnant women play a primary and influential role in such interventions because they have the ability to provide holistic and individualized care. This guidance should begin before conception and last through the postpartum period.

With only 30.8% of women gaining within the IOM recommended ranges, this study is consistent with other studies showing 30-40% of pregnant women in the U.S. gaining within the recommended guidelines (Olson, 2008; US Bureau of the Census, 2000). Research to date is lacking effective strategies for preventing excessive or inadequate GWG among women with varying sociodemographic characteristics. More research is needed to discern why women gain weight outside the IOM guidelines. The advice women are receiving appears to be ineffective in targeting appropriate weight gains during pregnancy. More studies are needed to assist in the development of better strategies to help healthcare providers motivate women to gain weight based on the IOM GWG recommended guidelines (Ferrari & Siega-Riz, 2012) or investigate whether those guidelines should be revised for all BMI groups.

References

Bodnar, L.M., Hutcheon, P. A., Platt, R. W., Himes, K. P., Simhan, H. N., & Abrams, B. (2011). Should gestational weight gain recommendations be tailored by maternal characteristics? *American Journal of Epidemiology, 174*, 136-146.

Brawarsky, P., Stotland, N. E., Jackson, R. A., Fuentes-Afflick, E., Escobar, G. J., & Rubashkin, N. (2005). Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. *International Journal of Gynecology and Obstetrics, 91*, 125-131.

Centers for Disease Control and Prevention (CDC). (2009). Pregnancy nutrition surveillance, system (PNSS): Nation summary of trends in maternal health indicators by race/ethnicity. Retrieved from http://www.cdc.gov/PEDNSS/pnss_tables/pdf/national_table20.pdf.

Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Solomon, C. G., & Markenson, G. (2008). Predictors of excessive and inadequate gestational weight gain in Hispanic women. *Obesity, 16* (7) 1657- 1666.

Davis, E. M., Babineau, D. C., Wang, X., Zyzanski, S., Abrams, B., Bodnar, L. M., & Horwitz, R. I. (2013). Short inter-pregnancy intervals, parity, excessive pregnancy weight gain and risk for maternal obesity. *Maternal Child Health Journal.* doi: 10.1007/s10995-013-1272-3.

Davis, E. M., Zyzanski, S. J., Olson, C. M., Stange, K. C., & Horowitz, R. I. (2009). Racial, ethnic, and socioeconomic differences in the incidence of obesity related to childbirth. *American Journal of Public Health, 99,* 294-299.

Ferrari, R. M., & Siega-Riz, A. M. (2012). Provider advice about pregnancy weight gain and adequacy of weight gain. *Maternal Child Health Journal.* doi: 10.1007/s10995-012-0969-z.

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults. 1999-2008. *Journal of the American Medical Association, 303*(3), 235-41.

Flegal, K. M., Carroll, M. D., Ogden, C. l., & Johnson, C. L. (2012). Prevalence and trends in obesity among US adults, 1999-2000. *Journal of the American Medical Association, 288,* 1723-1727.

Gillum, R. F., & Sempos, C. T. (2005). Ethnic variation in validity of classification of overweight and obesity using self-reported weigh and height in American women and men: the Third National Health and Nutrition Examination Survey. *Nutrition Journal 4,* 27. doi: 10.1186/1475-2891-4-27.

Gunderson, E. P., Quesenberry, C. P., & Lewis, C. E. (2004). Development of overweight associated with childbearing depends on smoking habit: The coronary artery risk development in young adults (CARDIA) study. *Obesity Research, 12,* 2041-2053.

Headen, I. E., Davis, E. M., Mujahid, M. S., & Abrams, B. (2012). Racial-ethnic differences in pregnancy-related weight. *Adv Nutr. 3*, 83-84. doi: 10.3945/an.111.000984.

Healthy People 2020. (2014). Maternal, infant, and child health. U.S. Department of Health and Human Services. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid

=26

Hinkle, S. N., Sharma, A. J., Schieve, L. A., Ramakrishnan, U., Swan, D. W., & Stein, A. D. (2012). Reliability of gestational weight reported postpartum: A comparison to the birth certificate. *Maternal and Child Health Journal.*

Hoke, M. M., Timmerman, G. A., & Robbins, L. K. (2006). Explanatory models of eating, weight, and health in rural Mexican American women. *Hispanic Health Care International, 4*(3), 143-151.

Howell, E. A., Mora, P. A., Horowitz, C. R., & Leventhal, H. (2005). Racial and ethnic differences in factors associated with early postpartum depressive symptoms. *Obstetrics and Gynecology, 105*,1442-1450. doi: 10.1097/01.

Institute of Medicine (IOM). (2009). Weight gain during pregnancy: Reexamining the guidelines, Washington, DC: National Academies Press.

Institute of Medicine (IOM). (1990). Nutrition during pregnancy, part 1: Weight gain. Part 11: Nutrients Supplements. Washington, DC. National Academies Press.

Institute of Medicine (IOM). (1985). Report of the committee to study the prevention of low birth weight: Preventing low birth weight. Washington, DC: National Academies Press.

Magann, E. F., Doherty, D. A., Chauhan, S. P., Klimpel, J. M., Huff, S. D., & Morrison, J. C. (2011). Pregnancy, obesity, gestational weight gain, and parity as predictors of peripartum complication. *Archives of Gynecology and Obstetrics, 284,* 827-836.

Oken, E., Taveras, E. M., & Klienman, K. P. (2007). Gestational weight gain and child adiposity at age 3 years. *American Journal of Obstetrics and Gynecology, 196,* (322), el-e8.

Olson, C. M. (2008). Achieving a healthy weight gain during pregnancy. *Annual Review of Nutrition, 28,* 411-423.

Olson, C. M., & Strawderman, M. S. (2003). Modifiable behavioral factors in a biopychosocial model predict inadequate and excessive gestational weight gain. *Journal of the American Dietetic Association, 103,* 48-54.

Olson, C. M., Strawderman, M. S., & Reed, R. G. (2004). Efficacy of an intervention to prevent excessive gestational weight gain. *American Journal of Obstetrics and Gynecology, 191,* 530-536.

Pender, N. J. (1996). *Health promotion in nursing practice* (3rd ed.). Connecticut, NJ: Appleton & Lange Stanford.

Peterson, S. J., & Bredow, T. S. (2009). *Middle range theories: Application to nursing research* (2nd ed.). Philadelphia, PA: Lippincott, Williams & Wilkins.

Rahman, M., & Berenson, A. B. (2012). Self-perception of weight gain among multiethnic reproductive-age women. *American Journal of Women's Health, 21*(3). doi: 10.1089/jwh.2011.2982.

Rasmussen, K. M., Abrams, B., Bodnar, L. M., Butte, N. F., Catalano, P. M., & Siega-Riz, A. M. (2010). Recommendations for weight gain during pregnancy in the context of the obesity epidemic. *Obstetric Gynecology, 116,* 1191-1195.

Rasmussen, K. M., Catalano, P. M., & Yatkine, A. L. (2009). New guidelines for weight gain during pregnancy: What obstetrician/gynecologists should know. *Current Opinion Obstetrician Gynecologist, 21,* 521-526. doi: 10.1097/GCO.0b013e328332d24e.

Rasmussen, K. M., & Yaktine, A. L. (2009). *Weight gain during pregnancy: Reexamining the guidelines*. Washington, DC: National Academies Press.

Sarwer, D. B., Allison, K. C., Gibbons, L. M., Tuttman-Markowitz, J., & Nelson, D. B. (2006). Pregnancy and obesity: A review and agenda of future research. *Journal of Women's Health 15,* 720-733.

Savitz, D. A., Stein, C. R., Siega-Riz, A. M., & Herring, A. H. (2011). Gestational weight gain and birth outcome in relation to prepregnancy body mass index and ethnicity. *Ann Epideimol, 21*, 78-85.

U.S. Bureau of the Census. (2000). Redistricting Data. Washington, DC: U.S. Census Bureau.

Walker, L. O., Hoke, M. M., & Brown, A. (2009). Risk factors for excessive or inadequate gestational weight gain among Hispanic women in a U.S.-Mexican border state. *Journal of Obstetrics, Gynecology, Neonatal Nurses, 38,* 418-429, doi: 10.1111/j.1552-6909.2009.01036.x

Wang, Y, & Beydoun, M. A. (2007). The obesity epidemic in the United States-gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiology Review, 29*, 6-28. [PubMed].

Wells, C. S., Schwalberg, R., Noonan, G., & Gabor, V. (2006) Factors influencing inadequate and excessive weight gain in pregnancy: Colorado, 2000-2002.

Maternal and Child Health Journal, 10, 55-62.

Zera, C., McGirre, S., & Oken, E. (2011). Screening for obesity in reproductive-aged women. (2011). *Centers for Disease Control and Prevention, 8*(6), A125.

Table 4

Characteristics and Descriptive Analysis of Subjects

Characteristic	**Mean (SD)**	**N**	**%**
Mean Age (y)	28.08(5.98)		
Pre-Pregnancy BMI	25.58(5.23)		
Maternal Height (inches)	63.36(3.11)		
GWG	31.39(14.17)		
Parity	1.15(1.19)		
Gestational Age (weeks)	39.24(1.03)		
Pre-pregnancy BMI			
Normal		153	51.90
Overweight		102	34.50
Obese		40	13.70
Race/Ethnicity			
White		143	48.50
Latina		113	38.30
Asian/Pacific Islander		21	7.20
Black/African American		9	3.10
American Indian or Alaskan Native		5	1.60
Other		4	1.40
Language			
English		218	73.90
Spanish		72	24.40
Other (Chinese, Hindi, Japanese, Vietnamese)		5	1.60
Marital Status			
Married		173	58.60
Single		114	38.60
Other (Divorced, Life Partner, Separated)		8	2.70
Medical Insurance			
Private (including Military)		153	51.90
Government		142	48.10
Healthcare Provider Type			
MD		246	85.40
CNM		42	14.60
Weight Gain by Recommended Categories			
Below		53	18.00
Within		91	30.80
Exceed		151	51.20

Table 5

Characteristics of Subjects by Pre-Pregnancy BMI Category

	Normal n (%)	**Overweight** n (%)	**Obese** n (%)	***F (df)***	X^2	***p***
Maternal Age (y)	27.46(6.03)	28.35(5.55)	26.83(6.53)	2.66(2)		0.07
Parity	.94(1.10)	1.23(1.16)	1.77(1.46)	8.13(2)		0.01*
Gestation Age	39.34(1.02)	39.19(1.05)	39.01(1.04)	1.76(2)		0.17
Race/Ethnicity					8.50(4)	0.08
White	75(48.70%)	47(46.90%)	21(52.50%)			
Latina	51(33.60%)	48(47.00%)	14(35.00%)			
Other	27(17.80%)	7(7.00%)	5(12.50%)			
Marital Status					4.39(4)	0.36
Single	64(42.10%)	32(31.70%)	17(42.50%)			
Married	83(54.60%)	66(65.30%)	23(57.50%)			
Other	5(3.30%)	3(3.00%)	0.00			
Language					1.999(2)	0.37
English	113(76.90%)	71(70.30%)	32(80.00%)			
Spanish	34(23.10%)	30(29.70%)	8(20.00%)			
Insurance					2.63(2)	0.27
Private	85(55.90%)	50(32.90%)	17(11.20%)			
Government	67(47.50%)	51(36.20%)	23(15.30%)			
Provider Type					2.15(2)	0.34
MD	125(85.60%)	82(82.80%)	39(92.50%)			
CNM	22(15.00%)	17(17.20%)	3(7.50%)			

Table 6

Characteristics of Subjects by GWG Pattern

	Below (n= 53)	**Within** (n = 91)	**Exceed** (n = 151)	*F (df)*	X^2	*p*
Mat. Age (y)	28.90(5.81)	27.70(6.44)	28.03(5.76)	.69(2)		0.50
Parity	1.38(1.23)	1.08(1.20)	1.12(1.17)	1.22(2)		0.30
Gestational Age	39.11(1.00)	39.38(.99)	39.21(1.07)	1.40(2)		0.25
Race/Ethnicity					4.44(4)	0.35
White	24(45.30%)	41(45.10%)	78(52.00%)			
Latina	19(35.80%)	41(45.10%)	52(34.70%)			
Other	10(18.90%)	9(9.80%)	20(13.30%)			
Language					1.88(2)	0.39
English	37(72.50%)	64(71.10%)	117(78.50%)			
Spanish	14(27.50%)	26(28.90%)	32(21.50%)			
Marital Status					1.89(4)	0.76
Single	20(37.70%)	40(44.00%)	54(35.80%)			
Married	31(58.50%)	49(53.80%)	93(61.60%)			
Other	2(3.80%)	2(2.20%)	4(2.60%)			
Insurance					2.74(2)	0.25
Private	32(60.40%)	42(46.20%)	79(52.30%)			
Government	21(39.60%)	49(53.80%)	72(47.70%)			
Provider					6.44(2)	0.04*
CNM	9(17.00%)	19(21.30%)	14(9.60%)			
MD	44(84.00%)	70(78.70%)	132(90.40%)			
Pre-Pregnancy BMI					13.12(4)	0.01*
Normal	33(62.30%)	56(61.10%)	64(42.70%)			
Overweight	14(26.40%)	29(32.20%)	59(38.70%)			
Obese	6(11.30%)	6(6.70%)	28(18.70%)			

Note: Pearson Chi-Square used to calculate group differences; ANOVAs used to determine group differences for continuous data (age, parity, gestational age). *p< .05

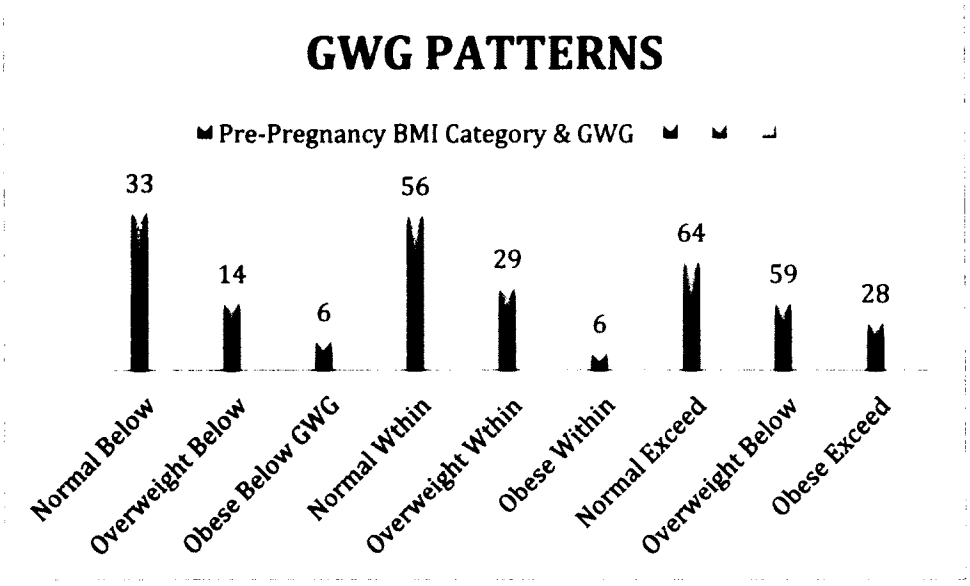

Figure 9. GWG patterns by pre-pregnancy BMI and GWG

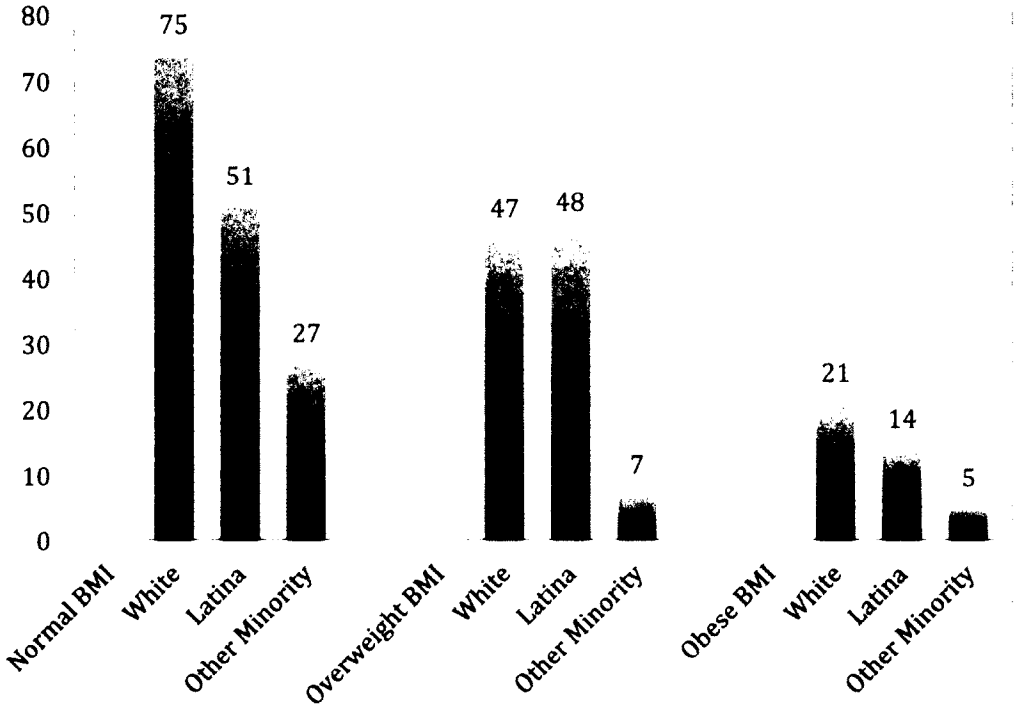

Figure 10. Race/ethnicity by pre-pregnancy BMI.

Correlates of Gestational Weight Gain

Within the 2009 IOM Recommended Guidelines

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CORRELATES OF WEIGHT GAIN

WITHIN THE 2009 IOM RECOMMENDED GUIDELINES

Abstract

Background: Overweight and obesity and physical inactivity were estimated to cost California over $21 billion in healthcare costs and lost productivity in 2000. California's 109% increase in obesity rates during the period 1991 to 2001 was the third highest in the nation. Among California women, the obesity rate has increased more rapidly than for men. Uncontrolled maternal diabetes and abnormal birth weight can contribute to overweight and obesity later in life (Dabelea & Crume, 2011). Extant research shows adverse pregnancy outcomes for both woman and child for weight gain above or below the Institute of Medicine (IOM) guidelines for gestational weight gain (GWG) based on pre-pregnancy BMI. Studies are needed to assess whether these guidelines are being recommended and followed and their correlates to inappropriate GWG.

Purpose: The purpose of this study was to examine GWG patterns among a group of racially, ethnically, and economically diverse women. The specific aim was to examine the correlates of GWG in women who gain weight within the 2009 IOM GWG recommended guideline.

Methods: A descriptive, correlational, cross-sectional design using retrospective data abstracted from medical records was used. A purposive sample of all women (N = 4500) who gave birth between January 1, 2011 and December 31, 2012 at a large multi-community hospital healthcare system in San Diego, CA provided data for this study. Inclusion criteria were singleton live birth, data on pre pregnancy BMI & GWG, $\geq$ 4 prenatal visits, and delivered at $\geq$ 37 weeks gestation. Parametric and non-parametric statistics were used including descriptive statistics, correlations, Chi-square, ANOVA, Post Hoc, and multivariate logistic regression to assess characteristics of the sample and examine relationships between the variables.

Results: Two hundred ninety five mothers met inclusion criteria. Study findings indicate women are gaining outside GWG recommendations at a higher rate than those gaining within GWG recommendations; 94 (31.9%) gained within guidelines and 201 (68.1%) gained outside the recommended range. Regardless of race, age, parity, marital status, primary language, and type of medical insurance, more than two-thirds (68.1%) of the mothers did not adhere to the recommendations. Provider type and pre-pregnancy BMI were significantly correlated to GWG category within and outside the recommended range. When controlling for the contribution of all the variables in the model, pre-pregnancy BMI was the only significant association. Women who gained within GWG

recommendations were more likely to have lower pre-pregnancy BMI (OR 0.924 [CI 0.868-0.983] with a *p* value of 0.01, showing statistical significance) than women who gained outside GWG recommendations. Therefore, the proportion of women with lower pre-pregnancy BMI was protective against inappropriate GWG gains by 92.4% with other factors controlled.

Implications: Findings from this study show pre-pregnancy BMI is a key factor in GWG. Healthcare providers and nurses are tasked with identifying modifiable and non-modifiable risk factors that could lead to GWG outside the IOM recommendations and work with women to decrease risk of adverse outcomes. Further research is needed to assist healthcare providers in helping women from racially, ethnically, and economically diverse backgrounds achieve ideal pre-pregnancy BMI to gain weight within the 2009 IOM GWG recommendations.

Introduction

Healthcare providers are charged to address the Maternal Infant Child Health (MICH-13) Healthy People 2020 objective of increasing the proportion of mothers who achieve the recommended weight gain during their pregnancies (Healthy People 2020, 2014). It is clear appropriate gestational weight gain (GWG) patterns remain a challenge for both healthcare providers and pregnant women. The Institute of Medicine (IOM) has placed an emphasis on improving patient outcomes and has tasked healthcare providers and researchers with developing substantial interventions to decrease the prevalence of adverse outcomes from inappropriate GWG that can lead to ill effects (Rasmussen, Catalano, & Yaktine, 2009). The 2009 IOM recommendations are in line with the new health care reform called the Affordable Care Act, which puts emphasis on improved health outcomes and change in healthcare delivery systems (Honoré & Scott, 2010).

Despite the knowledge generated from previous research studies, managing gestational weight remains a challenge for healthcare providers (Gillman, 2012). Further evidence is needed from racially, ethnically, and economically diverse populations to identify factors contributing to GWG problems, determine whether women are adhering to the recent 2009 IOM recommendations, and identify the barriers to adherence (Lovell, El Ansari, & Parker, 2010; Rasmussen, Catalano, & Yaktine, 2009).

Previous studies have found a direct link to lifelong obesity for women who gain too much weight during pregnancy if they had an overweight or obese pre-pregnancy body mass index (BMI). There is also a link to child obesity and adverse fetal and maternal outcomes if women gain weight below or above GWG recommendations (Rasmussen et al., 2009). Women with overweight and obese pre-pregnancy BMI who

gain excessive weight during pregnancy are more likely to have children who become overweight or obese during childhood (Catalano et al., 2009; Hillier, Pedula, Schmidt, Mullen, Charles, & Pettit, 2007; Huang, Lee, & Lu, 2007). Congenital anomalies have been associated with maternal overweight and obesity (e.g., neural tube defect, cardiovascular, septal defects, cleft lip and palate, hydrocephaly, anorectal atresia, and short limb reduction)(Stothard, Tennant, Bell, & Rankin, 2009). Recent studies suggest monitoring maternal BMI gains before and during pregnancy as they play an important role in determining obstetrical outcomes (Okhsenbein-Kolble, Roos, Gasser & Zimmermann, 2007; Olson, 2008).

Gaining too little weight or inadequate GWG is also a concern and may result in low-birth-weight babies, babies that are small for gestational age (SGA), intrauterine growth restriction, and preterm births with increased neonatal intensive care units (NICU) admissions, leading to higher incidence of neonatal morbidity and mortality (Han et al., 2011). The updated IOM GWG guidelines stem from growing evidence linking pre- and post-pregnancy weight gain to a number of health problems for both mother and baby.

The purpose of this study was to examine GWG patterns among a group of racially, ethnically, economically diverse women. The specific aim is to examine the correlates of GWG in women who gain within the 2009 IOM recommended guidelines.

Theoretical Framework

Health Promotion Model (HPM)

Pender's (1996) Health Promotion Model (HPM) guides this study. The model was created to explain and predict health-promoting components of lifestyle and emphasizes the relationship between person (patient characteristics), environment

(interpersonal/situational influences), and maternal and newborn outcomes. In this study, patient characteristics are pre-pregnancy BMI, age, race/ethnicity, and parity; interpersonal influences are socioeconomic status (i.e., private insurance or government-funded insurance) and healthcare provider (HCP) type (certified nurse midwife [CNM] or obstetrician [MD]); maternal outcomes are antepartum characteristics, GWG, intrapartum and postpartum outcomes, and newborn outcomes are newborn size, gestational age, and Apgar).

HPM provides a mechanism to identify sociodemographic, interpersonal, and personal characteristics associated with GWG patterns. Results of this study can help healthcare providers tailor interventions targeting behavioral changes to improve outcomes for women and children because this model identifies foci to develop future nursing interventions for health promotion to include exercise, nutrition, stress management, and social support (Pender, Murdaugh, & Pearsons, 2011).

Methods

Research Design, Sample, and Sampling

A retrospective cohort design was used for this study. Participants were selected from a sample of all women (N = 4,500) who gave birth between January 1, 2011 and December 31, 2012 at a large multi-community hospital healthcare system in San Diego County; 1,397 charts of mothers who delivered singleton babies were assessed and of these 621 cases were randomly selected and 320 met the inclusion criteria (women carrying singleton pregnancies, live births, and $\geq$ 4 prenatal visits).

Data for the analyses reported here were abstracted from Labor and Delivery electronic medical records (L&D EMR) and the main postpartum computerized charting

system used by the hospital; the EMR did not communicate with the postpartum computerized system; thus, data were abstracted both electronically and manually. All study procedures were reviewed and approved by the appropriate institutional review boards and administrators. Since the data were collected retrospectively, there was no actual patient contact that involved any risk. Precautions were taken to protect patient privacy in accordance with the Health Insurance Portability and Accountability Act (HIPAA); data were stored on a secured computer and de-identified prior to transferring the database for statistical analysis. Data abstraction procedures have been previously reported in the "Mother's Characteristics and Gestational Weight Gain Patterns article.

Measures

Pre-pregnancy BMI (kilogram/meter^2 or pounds/inches^2 x 702) was calculated from weight and height recorded in the L&D EMR and categorized based on the 2009 IOM guidelines as dictated by the World Health Organization (WHO) BMI criteria. Gestational weight gain (GWG) was defined as the difference between the maternal weight measured within one week prior to delivery or self-reported current admission weight and the weight recorded at the first prenatal visit or self-reported at the first prenatal visit.

Maternal age at delivery is the age recorded on the delivery record. Parity is defined as the number of deliveries after 20 weeks gestation. Gestational age (GA) was calculated from the first day of the last menstrual period to time of delivery or early ultrasound to obtain accurate due date. Medical coverage to identify socioeconomic (SES) status was categorized as government insurance and private insurance (including military insurance).

Statistical Analysis

Following completion of data collection, descriptive statistics were calculated for all analysis variables for a sample of 320 who met the inclusion criteria of singleton pregnancies, live births, ≥ 4 prenatal visits, and pre-pregnant BMIs. Upon review, the final sample for the regression (n = 295) excluded those women less than 37 weeks gestation (n = 19) and those with underweight pre-pregnancy BMI ≤18 (n = 6) due to small cell sizes. Race/ethnicity was categorized as White, Latina, or Other (African American, Native American/Alaskan Native, Asian) due to small cell size for each of the other minority groups. Recommended GWG categories were dichotomized to identify those who met the recommendations and those who did not. Pearson correlations examined relationships between continuous variables, point biserial correlations examined relationships between continuous and dichotomous variables, Chi-square tests evaluated relationships between categorical variables, and ANOVA were used to determine group differences. A multivariate logistic regression model was then fitted to the data. All analyses were conducted using Statistical Package for the Social Sciences (SPSS) version 22.0.

Results

Personal Characteristics, Environmental Factors, and Birth Outcomes

Table 7 displays personal characteristics, environmental factors, and maternal and newborn maternal outcomes for the original sample of 320 cases (including frequencies of Apgar scoring, duration of pregnancy, newborn size by gestational age, antepartum, intrapartum, and postpartum) and characteristics for the final sample of 295 primary

study cases (excludes fewer than 37 weeks gestation n =19 and underweight pre-pregnancy BMI =6).

In the original sample (n=320), maternal mean age was 28.08 (SD=5.98). The sample was racially/ethnically diverse with 156 (48.6%) identifying as "White," 119 (37.1%) as "Latina," and 45 (13.9%) identifying as "Other" ethnic or racial groups (including Asians, African Americans, and American Indians). More than half (n = 188, 58.8%) were married, 124 (38.8%) were single, and 8 (2.4%) reported some other relationship status such as domestic partner or divorced. Over 80% (267, 83.4%) had an MD for a healthcare provider. Forty-one (12.8%) received Pitocin induction, 61 (19%) received Pitocin augmentation, and slightly more than two-thirds (210; 65.6%) had vaginal deliveries; few had postpartum complications such as postpartum hemorrhage and infection (12; 3.9%). There were few (19; 5.8%) pre-term births, and the majority of infants had a newborn size appropriate for gestational age (Table 7).

GWG Within and Outside Recommended Guidelines

Chi-square analyses indicated there was a statistically significant positive relationship between GWG and pre-pregnancy BMI ($x^2(2) = 7.91, p < .02$) and type of provider (MD or CNM; $x^2(1) = 5.28, p < .02$, Fisher's Exact Test p = < .02 and < .03, respectively). Women with lower pre-pregnancy BMIs and had CNMs as healthcare providers were positively associated with GWG within the recommended range. The women in this study were 6.5 times more likely to have an MD healthcare provider than a CNM, and they were more likely to have private medical insurance if they had an MD than a CNM. There were no statistically significant relationships between GWG category and marital status, primary language, and race/ethnicity (Table 8).

Other Study Variable Relationships

A logistic regression examining predictors for recommended weight gain tested the strength of association of age at delivery, pre-pregnancy BMI, parity, race/ethnicity, insurance, and provider. When controlling for the contributions of all the variables in the model, pre-pregnancy BMI was the only statistically significant association to GWG within recommended range. Table 9 displays the Logistic regression and indicates the overall model of 6 predictors (age, parity, insurance type, provider type, pre-pregnancy BMI, & race/ethnicity) was statistically reliable, but not a great fit in distinguishing between mothers who gained within and outside recommended GWG (- 2Log Likelihood = 337.495; χ^2 (7) = 14.83, p = *.038).* The model correctly classified only 69.8% of the cases. Wald statistics indicate pre-pregnancy BMI (6.42, p = *.01, O/R .92)* was the only variable to significantly predict recommended GWG.

Women who gain within the GWG recommendations are more likely to have lower pre-pregnancy BMI (OR 0.92 [CI 0.868-0.983]), with a p value of 0.01 showing statistical significance) than women who gain outside GWG recommendations. In other words, the proportion of women with lower pre-pregnancy BMI was protective against gaining outside GWG recommendations by 92.4% with other factors controlled (Table 9).

Discussion/Implications

This study examined the correlates of GWG in women who gain within the 2009 IOM recommended guidelines. Women with higher pre-pregnancy BMI tend to exceed the recommended GWG range (x^2 = 7.91(2), p = .02, Fisher's Exact .02). This supports previous findings of Rasmussen and Yaktine (2009), who reported overweight and obese pre-pregnancy BMI increase a woman's chances of excessive GWG. As an experienced

obstetrical nurse this researcher can corroborate this is often the case, although women with normal pre-pregnancy BMI are gaining momentum in excessive GWG and contributing to obesity in the population.

This study did not show a significant relationship between mode of delivery and GWG pattern, in contrast to previous studies where excessive GWG and high pre-pregnancy BMI were associated with intrapartum complications such as increased rates of induction of labor and caesarean deliveries when compared to women with normal pre-pregnancy BMI (Chua, Kim, Schmid, Dietz, Callaghan, & Lau, 2007). Rates of primary and repeat caesarean delivery are higher in women with excessive GWG and higher pre-pregnancy BMI than in women with normal pre-pregnancy BMI (Herring, Rose, Skouteris & Oken, 2012; Muktabhant, Lumbiganon, Ngamjarus, & Dowswell, 2012; Chu et al., 2007; Cedergren, 2006; Weiss, 2004). Mode of delivery was not statistically significant; of the 94 cases within the recommended GWG range, 28 delivered by caesarean section compared to 76 who gained outside the recommended GWG.

Higher parity was not significantly associated with GWG (x^2=3.17(5), p = .67). This contrasts with studies that report giving birth to one child compared to never having children could double the risk of high GWG and contribute to obesity over 5-10 years (Davis, Zyzanski, Olson, Stange, & Horwitz, 2009; Gunderson et al., 2004) and having at least two children could lead to greater increase in obesity (Magann, Doherty, Chauhan, Klimpel, Huff, & Morrison, 2011). A recent study by Davis et al. (2013) found multiparous women with short inter-pregnancy intervals with or without excessive GWG had increased risk of obesity after childbirth compared to multiparous women with longer

inter-pregnancy intervals. In the study reported here, data on the time between pregnancies was not available. More studies are needed to examine the relationship between parity, GWG, and risk for obesity by looking at the length of the interval between pregnancies.

Medical insurance showed no statistical significance (x^2=2.40(1), p = .12, Fisher's Exact .13) to recommended GWG. Although more women with private insurance gained outside the GWG recommendation, it was not statistically significant. Previous studies have produced mixed results when taking into account women's medical insurance status, SES, race/ethnicity, and GWG. Chasan-Taber et al. (2008) reported SES was not associated with excessive GWG, but other studies reported Hispanic women with government-funded medical insurance is a strong indicator of risk for maternal morbidity such as excessive GWG and obesity. The differences may be due to how GWG is measured or due in part to cross-cultural differences in norms pertaining to ideal body image, wellness, and financial security (Wang & Beydoun, 2007).

Healthcare provider type was significantly associated with GWG (x^2=5.28(1), p =.02, Fisher's Exact Test, p =.03), indicating women who had an MD exceeded GWG recommendation compared to women who had a CNM. Previous studies have found many obstetricians do not adjust their GWG advice according to a patient's pre-pregnancy BMI and over half of women believe their education on weight management during pregnancy was inadequate or non-existent (Callaway, O'Callaghan, & McIntyre, 2009, Power, Cogswell, Schulkin, 2009; Stotland et al., 2005). Stewart, Wallace, and Allen (2012), showed a higher proportion of obstetrical staff than midwives reported they did not weight women at any time (43% vs. 13%, $p < .05$). Twenty-two percent of

participants reported not advising, most identified no particular reason for omission, 5% felt uncomfortable discussing weight, and 4% were worried that discussing weight could cause undue stress to the patient. Data for the findings reported here did not include this level of detail but may reflect this lack of knowledge and thus could support Stewart et al.'s findings, as women under the care of obstetricians gained outside the recommended GWG guidelines more often than those under the care of CNMs. Interventional studies and more educational support are needed to help healthcare providers recognize this as an issue to be addressed when caring for women of childbearing age and handle weight issues when caring for pregnant women.

A previous study showed many pregnant women receive prenatal information they do not want and do not receive the information they do want from their healthcare providers (Collins, 2007). In this study there were significant relationships between healthcare provider type and GWG within recommended guidelines. The women in this study were 6.5 more likely to have an MD healthcare provider than a CNM; women receiving perinatal services from MDs were more likely to have private insurance, yet women who had CNMs were more likely to have GWGs within recommended guidelines compared to women who had MDs. Although a significant relationship was found between provider type and GWG, there was no statistical significance when the logistic regression was performed; this may be due to the small sample of women who had CNMs (42, 14.6%) compared to (246, 85.4%) who had MDs or due to the need to control for other confounding variables.

When it comes to healthcare providers discussing appropriate weight gain during pregnancy, there is a disconnect because providers recall giving advice for gestational

weight gain, healthy eating, physical activity while women rarely recall receiving such advice. Providers were apprehensive due to the sensitive nature of addressing weight, especially a patient who is obese (Stotland, Tsoh, & Gerbert, 2011). Additionally, advice women receive antenatally on weight gain, diet, and exercise is brief and usually not related to weight management (Brown & Avery, 2012). Women need an individualized approach regarding weight management. In a study conducted by Ferrari and Siega-Riz (2012), 78% of women gained outside the 2009 GWG recommendations and of these 51% reported receiving weight gain advice from their healthcare provider. In a qualitative study by Stotland et al. (2011), nurse practitioners and midwives expressed higher confidence in their training and skills regarding lifestyle counseling when compared to obstetricians/gynecologists. This study revealed women with an MD provider gained outside the recommendation more often than those with a CNM provider. However, this study's data does not allow for exploration into reasons for this finding. Future studies using a qualitative approach could be beneficial to explore other contributing factors and identify ways to overcome barriers.

Limitations

These findings must be interpreted in the light of several study limitations: the retrospective design, data abstraction of EMRs, potential coding error, and use of self-reports in documentation.

Some variables that may play a role in GWG were not considered because they were not available or were inconsistently reported (e.g., educational attainment, smoking, illicit drug use, alcohol intake, and eating disorders); therefore, the researcher did not include them in the analysis. Additionally, women may have been reluctant to share their

real social history. Sample selection and target population of the hospital limit generalizability since true randomization could not be used. Notably, only women with normal, overweight, and obese pre-pregnancy BMI and who received adequate prenatal care were included; those who did not receive prenatal care and underweight BMI groups, which are also considered high-risk groups, were excluded.

Regardless, taken in context, findings from this study are encouraging and provide additional data for healthcare and policy agencies in addressing GWG issues. This study supports normal pre-pregnancy BMI increases the odds of GWG within the recommended range, and it also highlights the importance of providing all women individualized education and relevant interventions specific to moderating pre-pregnancy BMI and GWG outside the recommendations.

Conclusion

The advice women receive is ineffective in targeting appropriate weight gains during pregnancy; more studies are needed to find better strategies for providers to motivate and assist women gain weight within the IOM GWG recommended guidelines (Ferrari & Siega-Riz, 2012). According to Rasmussen et al. (2009), more research including experimental studies are needed to illuminate why women gain outside the IOM guidelines. Healthcare practitioners should find out more about women's beliefs about weight and provide accurate and timely advice about ideal BMI in the preconception period. Women with normal, overweight, and obese BMI need individualized interventions to maintain or achieve an ideal BMI range, as it was found women in all three BMI categories exceed GWG recommendations at an astonishing rate. Additionally, more study is needed with women in the obese BMI categories to identify if

the target GWG range of 11-20 pounds is appropriate for all obese classes or even stricter ranges should be developed.

Once a woman becomes pregnant, healthcare providers need to develop individualized interventions to help the woman and other members of the healthcare team maintain ideal GWG. This approach might be a good start in helping women to achieve the desired GWG based on pre-pregnancy BMI. Clearly, patient knowledge and healthcare provider advice are modifiable factors regardless of age, race/ethnicity, marital status that need to be addressed in efforts to help women gain within the IOM GWG guidelines. Finally, there is a need to improve the curricula in medical and nursing schools on the topics of nutrition, exercise, and prenatal counseling to include psychological and cultural approaches.

References

Brawarsky, P., Stotland, N. E., Jackson, R. A., Fuentes-Afflick, E., Escobar, G. J., & Rubashkin, N. (2005). Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. *International Journal of Gynecology and Obstetrics, 91*, 125-131.

Brown, A., & Avery, A. (2012). Healthy weight management during pregnancy: What advice and information is being provided? *Journal of Human Nutrition and Dietetics, 25*, 378-388. doi:10.1111/j.1365-277X.2012.01231.x

Dabelea, D., & Crume, T. (2011). Maternal environment and the trasngenerational cycle of obesity and diabetes. *Diabetes, 60*, 1845-1855.

Callaway, L. K., O'Callaghan, M. J., & McIntyre, H. D. (2009). Barriers to addressing overweight and obesity before conception. *Medical Journal of Australia, 19*(8), 425-428.

Catalano, P. M., Farrell, K., Thomas, A., Huston-Presley, L., Mencin, P., Hauguel de Mouzon, & Amini, S. B. (2009). Perinatal risk factors for childhood obesity and metabolic dysregulation. *American Journal of Clinical Nutrition, 90,* 1303-1313.

Cedergren, M. I. (2006). Effects of gestational weight gain and body mass index on obstetric outcome in Sweden. *International Journal of Gynecology and Obstetrics, 93(3), 269-74.*

Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Solomon, C. G., & Markenson, G. (2008). Predictors of excessive and inadequate gestational weight gain in Hispanic women. *Obesity, 16*(7), 1657- 1666.

Chua, S. C., Kim, S. Y., Schmid, C. H., Dietz, P. M., Callaghan, W. M., & Lau, J. (2007). Maternal obesity and cesarean delivery: A meta-analysis. *American Journal of Obstetrics and Gynecology, 8*(5), 385-94.

Collins, C. (2007). The discrepancy between the information pregnant women expect and receive in Ireland and lost opportunity for health promotion and education. *International Journal of Health Promotion and Education, 45*(2), 61-66.

Davis, E. M., Babineau, D. C., Wang, X., Zyzanski, S., Abrams, B., Bodnar, L. M., & Horwitz, R. I. (2013). Short inter-pregnancy intervals, parity, excessive pregnancy weight gain and risk for maternal obesity. *Maternal Child Health Journal, Springer,* doi: 10.1007/s10995-013-1272-3

Davis, E. M., Zyzanski, S. J., Olson, C. M., Stange, K. C., & Horowitz, R. I. (2009). Racial, ethnic, and socioeconomic differences in the incidence of obesity related to childbirth. *American Journal of Public Health, 99,* 294-299.

Ferrari, R. M., & Siega-Riz, A. M. (2012). Provider advice about pregnancy weight gain and adequacy of weight gain. *Maternal Child Health Journal.* doi: 10.1007/s10995-012-0969-z.

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults. 1999-2008. *Journal of the American Medical Association, 303*(3), 235-41.

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Johnson, C. L. (2012). Prevalence and trends in obesity among US adults, 1999-2000. *Journal of the American Medical Association, 288,* 1723-27.

Gillman, M. W. (2012). Gestational weight gain: Now and the future. *Circulation, 125*(11),1330-1340.

Gillum, R. F., & Sempos, C. T. (2005). Ethnic variation in validity of classification of overweight and obesity using self-reported weigh and height in American women and men: The third national health and nutrition examination survey. *Nutrition Journal, 4,* 27. doi: 10.1186/1475-2891-4-27.

Gunderson, E. P., Quesenberry, C. P., & Lewis, C. E. (2004). Development of overweight associated with childbearing depends on smoking habit: The coronary artery risk development in young adults (CARDIA) study. *Obesity Research, 12,* 2041-2053.

Han, Z., Lutsiv, O., Mulla, S., Rosen, A., Beyene, J., & McDonald, S. D. (2011). Low gestational weight gain and the risk of preterm birth and low birthweight: A systematic review and meta-analysis. *ACTA Obstetricia et Gynecologica 90,* 935-954.

Healthy People 2020. (2014). Maternal, infant, and child health. U.S. Department of Health and Human Services. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=26

Herring, S. J., Rose, M. Z., Skouteris, H., & Oken, E. (2012). Optimizing weight gain in pregnancy to prevent obesity in women and children. *Diabetes, Obesity, & Metabolism, 14*(3), 195-203.

Hillier, T., A., Pedula, K. L., Schmidt, M. M., Mullen, J. A., Charles. M. A., & Pettit, D., J. (2007). Childhood obesity and metabolic imprinting: The ongoing effects of maternal hyperglycemia. *Diabetes Care, 30*, 2287-2292.

Hinkle, S. N., Sharma, A. J., Schieve, L. A., Ramakrishnan, U., Swan, D. W., & Stein, A. D. (2012). Reliability of gestational weight reported postpartum: A comparison to the birth certificate. *Maternal and Child Health Journal, 17*(4), 756-65. doi: 10.1007/s10995-012-1057-0.

Hoke, M. M., Timmerman, G. A., & Robbins, L. K. (2006). Explanatory models of eating, weight, and health in rural Mexican American women. *Hispanic Health Care International, 4*(3), 143-151.

Honoré, P.A., & Scott, W. (2010). Priority areas for improvement of quality in public health. Washington, DC: Department of Health and Human Services. Retrieved from http://www.hhs.gov/ash/initiatives/quality/quality/improvequality2010.pdf

Howell, E. A., Mora, P. A., Horowitz, C. R., & Leventhal, H. (2005). Racial and ethnic differences in factors associated with early postpartum depressive symptoms. *Obstetrics and Gynecology, 105*, 1442-1450. doi: 10.1097/01.

Huang, J. S., Lee, T. A., & Lu, M. C. (2007). Prenatal programming of childhood overweight and obesity. *Maternal and Child Health Journal, 11*, 461-473.

Institute of Medicine. (IOM). (2009). Weight gain during pregnancy: Reexamining the guidelines, Washington, DC: National Academies Press.

Institute of Medicine. (IOM). (1990). Nutrition during pregnancy, part 1: Weight gain.

Part 11: Nutrient supplements. Washington, DC. National Academies Press.

Institute of Medicine (IOM). (1985). Committee to study the prevention of low birth weight: Preventing low birth weight. Washington, DC: National Academies Press.

Lovell, G. P., El Ansari, W., & Parker, J. K. (2010). Perceived exercise benefits and barriers of non-exercising female university students in the United Kingdom. *International Journal of Environmental Research and Public Health 7,* 784-798. Doi: 10.3390/ijerph7030784.

Magann, E. F., Doherty, D. A., Chauhan, S. P., Klimpel, J. M., Huff, S. D., & Morrison, J. C. (2011). Pregnancy, obesity, gestational weight gain, and parity as predictors of peripartum complication. *Archives of Gynecology and Obstetrics, 284,* 827-836.

Muktabhant, B., Lumbiganon, P., Ngamjarus, C. Dowswell, T. (2012). Interventions for preventing excessive weight gain during pregnancy. *Cochrane Database System Review,* 4, CD007145.

Oken, E., Taveras, E. M., & Klienman, K. P. (2007). Gestational weight gain and child adiposity at age 3 years. *American Journal of Obstetrics and Gynecology, 196,* (322), el-e8.

Ochsenbein-Kolble, N., Roos, M., Gasser, T., & Zimmermann, R. (2007). Cross-sectional study of weight gain and increase in BMI throughout pregnancy. *European Journal of Obstetrics & Gynecology and Reproductive Biology, 130*(2), 180-186.

Olson, C. M. (2008). Achieving a healthy weight gain during pregnancy. *Annual Review*

of Nutrition, 28, 411-423.

Olson, C. M., & Strawderman, M. S. (2003). Modifiable behavioral factors in a biopychosocial model predict inadequate and excessive gestational weight gain. *Journal of the American Dietetic Association, 103,* 48-54.

Olson, C. M., Strawderman, M. S., & Reed, R. G. (2004). Efficacy of an intervention to prevent excessive gestational weight gain. *American Journal of Obstetrics and Gynecology, 191,* 530-536.

Pender, N. J. (1996). *Health promotion in nursing practice* (3rd ed.). Connecticut, NJ: Appleton & Lange Stanford.

Pender, N. J., Murdaugh, C. L., & Parsons, M. A. (2011). *Health promotion in nursing research* (6th ed). Upper Saddle, NJ: Pearson.

Peterson, S. J., & Bredow, T. S. (2009). *Middle range theories: Application to nursing research* (2nd ed.). Philadelphia, PA: Lippincott, Williams & Wilkins.

Power, M. L. Cogswell, M. E., & Schulkin, J., (2006). Obesity prevention and treatment practices of U.S. obstetrician-gynecologists. *Obstetrics and Gynecology, 108,* 961-968.

Rahman, M., & Berenson, A. B. (2012). Self-perception of weight gain among multiethnic reproductive-age women. *American Journal of Women's Health, 21* (3). doi: 10.1089/jwh.2011.2982.

Rasmussen, K. M., Abrams, B., Bodnar, L. M., Butte, N. F., Catalano, P. M., & Siega-Riz, A. M. (2010). Recommendations for weight gain during pregnancy in the context of the obesity epidemic. *Obstetric Gynecology, 116,* 1191-1195.

Rasmussen, K. M., Catalano, P. M., & Yatkine, A. L. (2009). New guidelines for weight

gain during pregnancy: What obstetrician/gynecologists should know. *Current Opinion Obstetrician Gynecologist, 21,* 521-526. doi: 10.1097/GCO.0b013e328332d24e.

Rasmussen, K. M., & Yaktine, A. L. (2009). *Weight gain during pregnancy: Reexamining the guidelines*. Washington, DC: National Academies Press.

Sarwer, D. B., Allison, K. C., Gibbons, L. M., Tuttman-Markowitz, J., & Nelson, D. B. (2006). Pregnancy and obesity: A review and agenda of future research. *Journal of Women's Health 15,* 720-733.

Stewart, Z. A., Wallace, E. & Allan, C. (2012). Weight gain in pregnancy: A survey of current practice in a teaching hospital. *Australian and New Zealand Journal of Obstetrics and Gynecology, 22*(2), 208-210.

Stothard, K. J., Tennant, P. W. G., Bell, R., & Rankin, J. (2009). Maternal overweight and obesity and the risk of congenital anomalies: A systematic review and meta-analysis. *Journal of the American Medical Association, 301*, 636-650.

Stotland, N. E., Haas, J. S., Brawarsky, P., Jackson, R. A., Fuentes-Afflick, E. & Escobar, G. J. (2005). Body mass index, provider advice, and target gestational weight gain. *Obstetrics and Gynecology, 105, 633-638*

Stotland, N., Tsoh, J. Y., & Gilbert, B. (2011). Prenatal weight gain: Who is counseled? *Journal of Women's Health.* doi: 10.1089/jwh.2011.2922

U.S. Bureau of the Census. (2000). Census 2000: Redistricting data. Washington, DC: U.S. Census Bureau.

Walker, L. O., Hoke, M. M., & Brown, A. (2009). Risk factors for excessive or

inadequate gestational weight gain among Hispanic women in a U.S.-Mexican border state. *Journal of Obstetrics, Gynecology, & Neonatal Nurses, 38,* 418-429, doi: 10.1111/j.1552-6909.2009.01036.x

Wang, Y, & Beydoun, M. A. (2007). The obesity epidemic in the United States-gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiology Review, 29*, 6-28. [PubMed].

Weiss, J. L., Malone, F. D., Emig, D., Ball, R. H., Nyberg, D. A., & Comstock, C. H. (2004). Obesity, obstetric complications and cesarean delivery rate- a population-based screening study. *American Journal of Obstetrics and Gynecology, 190*(4), 1091-1097.

Wells, C. S., Schwalberg, R., Noonan, G., & Gabor, V. (2006) Factors influencing inadequate and excessive weight gain in pregnancy: Colorado, 2000-20002. *Maternal and Child Health Journal, 10*, 55-62.

Zera, C., McGirre, S., & Oken, E. (2011). Screening for obesity in reproductive-aged women. (2011). *Centers for Disease Control and Prevention 8*, (6), A125.

Table 7

Characteristics of Sample 1(N = 320) and Primary Sample 2 (N = 295)

	Sample 1 N = 320		**Sample 2 N = 295**	
Variable	**Mean(SD)**	**n (%)**	**Mean(SD)**	**n (%)**
Age	28.08(5.98)		28.08(5.98)	
Pre-pregnancy BMI	25.28(5.32		25.58(5.23)	
GWG	31.4(14.48)		31.39(14.1)	
Parity	1.14(1.2)		1.15(1.2)	
Gestational Age (weeks)	39.0(1.85)		39.24(1.03)	
Pre-pregnancy BMI				
Underweight		6(1.9)		
Normal		164(51.3)		153(51.9)
Overweight		106(33.1)		102(34.5)
Obese		44(13.8)		40(13.7)
Race/Ethnicity				
White		156(48.8)		143(48.5)
Latina		119(37.2)		113(38.3)
Asian/Pacific Islander		21(6.6)		21(7.2)
Black/African American		9(2.8)		9(3.1)
American Indian or Alaskan Native		5(1.6)		5(1.6)
Other		10(3.0)		4(1.4)
Language				
English		239(74.7)		218(73.9)
Spanish		75(23.4)		72(24.4)
Other (Chinese, Hindi, Japanese, Vietnamese		6(2.0)		5(1.6)
Marital Status				
Married		188(58.8)		173(58.6)
Single		124(38.8)		142(38.6)
Other (Divorced, Life Partner, Separated)		8(2.4)		8(2.7)
Medical Insurance				

Private (including Military)	190(59.4)	153(51.9)
Government	130(40.6)	142(48.1)
Healthcare Provider Type		
MD	267(83.4)	246(85.4)
CNM	46(14.6)	42(14.6)
CNM/MD	7(2.2)	
Weight Gain by Recommended Categories		
Below		53(18.0)
Within		91(30.8)
Exceed		151(51.2)
Alcohol		
No	318(99.4)	
Yes	2(0.6)	
Drugs		
No	314(98.1)	
Yes	6(1.9)	
Smoking		
No	315(98.4)	
Yes	5(1.6)	
Parity		
0	117(36.6)	
1	103(32.2)	
2	59(18.4)	
3	21(6.6)	
4	12(3.8)	
5	6(1.9)	
Pitocin Augmentation		
No	259(80.9)	
Yes	61(19.0)	
Induction of Labor		
No	273(87.2)	
Pitocin	41(12.8)	
Gel Induction	7(2.2)	
Failed Induction		
No	310(96.9)	
Yes	10(3.11)	
Mode of Delivery		
Vaginal	210(65.6)	
Cesarean	110(34.4)	
Laceration	206(64.4)	
No	114(35.6)	
Yes		
Postpartum		

Complication	
Postpartum Hemorrhage	10(3.1)
Postpartum Infection	2(0.8)
None	308(96.3)
Duration of Pregnancy	
Less than 37 weeks	19(5.9)
37 weeks or greater	301(94.1)
Newborn Size by Gestational Age	
Appropriate for Gestational Age (AGA)	265(89.8)
Large for Gestational Age (LGA)	28(9.5)
Small for Gestational Age (SGA)	1(0.3)
Apgars at 1 minute	
Less than 7	20(6.3)
7	23(7.2)
8	196(61.3)
9	79(24.7)
10	1(0.3)
Apgars at 5 minutes	
Less than 7	4(1.2)
7	1(0.3)
8	17(5.3)
9	293(91.6)
10	4(1.3)

Table 8

Dichotomous Gestational Weight Gain Patterns (Outside and Within Recommended)

	Within Recommended GWG n = 94(31.9)	Outside GWG Recommendation N = 201(68.1)	X^2	*P Value*	Fisher's Exact
Variable					
Pre-pregnancy BMI			7.91(2)	.02*	.02*
Normal	56	97			
Overweight	29	73			
Obesity	6	34			
Parity			3.17(5)	.67	
0	39	65			
1	26	72			
2	17	38			
3	6	13			
4	4	8			
5	1	4			
Primary Language			.72(1)	.40	.47
English	67	151			
Spanish	26	46			
Marital Status			1.69(1)	.19	.21
Single	41	73			
Married	51	122			
Race/Ethnicity			1.56(1)	.21	.23
White	43	100			
Latina	42	70			
Medical Insurance			2.40(1)	.12	.13
Medical-Gov	44	75			
Private	50	126			
Mode of delivery			1.81(1)	.18	.19
Vaginal	66	125			
Cesarean	28	76			
Provider Type			5.28(1)	.02	.03*
CNM	21	34			
MD	77	185			

Note: Pearson Chi-square was used to calculate group differences and Fisher's Exact significance at $*p < .05$

Table 9

Logistic Regression for Predicted GWG Group (Outside or Within Recommended GWG)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	AGEATVISIT	.018	.027	.446	1	.504	1.018
	PREPREGBMI	**-.082**	**.032**	**6.420**	**1**	**.011**	**.921**
	PARITY	-.080	.139	.333	1	.564	.923
	InsuranceType(1)	.243	.317	.584	1	.445	1.274
	Provider(1)	-.597	.385	2.405	1	.121	.551
	Race			1.543	2	.462	
	Race(1)	.219	.322	.462	1	.497	1.245
	Race(2)	-.365	.433	.711	1	.399	.694
	Constant	1.176	1.065	1.218	1	.270	3.242

a. Variable(s) entered on step 1: AGEATVISIT, PREPREGBMI, PARITY, InsuranceType, Provider, Race.

Appendix B

PH IRB Approval and Addendum

MEDICAL STAFF SERVICES

PALOMAR
POMERADO
HEALTH

May 10, 2013

Melissa Rouse, R.N.
Palomar Health
15525 Innovation Drive
San Diego, CA 92128

RE: Correlates of Gestational Weight Gain Patterns

Dear Ms. Rouse:

The Palomar Health Investigational Review Committee, in its meeting of May 9, 2013, reviewed and approved the protocol for the above-mentioned study. The Committee also approved the request for a waiver of HIPAA authorization in order to conduct this study as it was determined that all of the required conditions have been satisfied. The study was also granted a waiver of informed consent requirements as it was determined that the criteria in 45CFR46.116(d) have been satisfied. The study was approved to be conducted at Palomar Medical Center and Pomerado Hospital.

Prior to initiation of the study, approval must also be obtained from the Administration of the Hospital(s) involved. Studies approved by the Investigational Review Committee may not proceed until after administrative approval is obtained. Please contact Melissa Wallace at (760) 480-7988 or Danny Delosantos at (760)480-7939 for information on the administrative review process. Study specific laboratory and imaging studies that will be performed as part of the study are required to be ordered on the appropriate form.

The Palomar Health Investigational Review Committee is in compliance with Federal Rules and Regulations and operates in accordance with Good Clinical Practices. Approval of this protocol and informed consent is effective for one (1) year from the initial approval and may not proceed past May 9, 2014 without reapproval by the Palomar Pomerado Investigational Review Committee.

Sincerely,

Richard G. Just, M.D.
Chairman, Investigational Review Committee

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Tel 858.613.4664 Fax 858.613.4217