Pregnancy and maternal outcomes based on adherence to the current maternal weight gain recommendations for pregnant women with obesity

by

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Abstract

BACKGROUND AND PURPOSE: Pre-pregnancy obesity increases the risk of gestational complications and affects 30% of pregnancies in the U.S. The current pregnancy weight gain recommendations for women with obesity are based on limited and somewhat conflicting data. The purpose of this study was to investigate whether adherence to current pregnancy weight gain recommendations is associated with the best birth and maternal outcomes among women with obesity.

METHOD: Kansas Department of Health and Environment summary tables for certificates of live births for mothers with a BMI > 30 for years 2014-2019 were analyzed. Weight gain was classified as 1) less than recommended, 2) recommended, or 3) more than recommended. Birth outcomes, maternal outcomes, and delivery method were compared using relative risk (RR) with 95% confidence intervals (CI).

RESULTS/FINDINGS: The majority (54.8%) of mothers with obesity gained more weight than recommended. Compared to the recommended weight gain, gaining more than recommended decreased the risk of low birth weight (RR 0.66; 95% CI 0.61-0.72), increased risk of hypertension (RR 1.32; 95% CI 1.29-1.40), and increased risk of cesarean birth (RR 1.07; 95% CI 1.05-1.10). Compared to the recommended weight gain, gaining less than recommended was associated with increased risk of low birth weight (RR 1.35; 95% CI 1.24-1.47), decreased risk of hypertension (RR 0.90; 95% CI 0.83-0.97), and decreased risk of cesarean birth (RR 0.95; 95% CI 0.92-0.98).

CONCLUSION: Gestational weight gain above recommended values was common and increased the risk of gestational hypertension and cesarean birth but also decreased the risk of low birth weight.

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Chapter 1 - Introduction

With overall obesity prevalence having more than doubled since 1980, obesity has become a common clinical issue affecting one-third of the world's population. (Chooi et al., 2019). Obesity is more prevalent in women than in men and is widespread among women in their child-bearing years (Chooi et al., 2019). In 2019, pre-pregnancy obesity was prevalent in 29% of pregnant women in the U.S. (Driscoll & Gregory, 2020). Obesity during pregnancy increases the risk of gestational complications for both mother and fetus. These complications include an increased risk of cesarean section, still birth, instrumental delivery methods, fetal distress, fetal insulin resistance, gestational diabetes, preeclampsia, and higher birth weights (Cedergren, 2004; Zhang et al., 2023). In their review, Norman & Reynolds (2011) discuss how the prevalence of obesity during pregnancy is continuing to increase as rates of obesity for the general population are also increasing. They state that obesity during pregnancy increases a wide variety of complications, including minor ones. While these minor complications (e.g., heartburn, symphysis pubic discomfort, back pain) may not increase risk of mortality, they increase pain for the pregnant women and increase the burden on the healthcare system. Maternal obesity during pregnancy also increases risk factors later in life for the offspring, including increased risk of contracting diabetes, experiencing stroke, cardiovascular disease, and obesity as an adult (Gaillard, 2015).

Fakhraei et al. (2022) performed a systemic review looking at predictors of adverse pregnancy outcomes in pregnant women living with obesity. In this review they included 61 studies from 16 different countries, published between 2009 and 2020. The following outcomes were evaluated: gestational diabetes, low birth weight, preterm birth, preeclampsia, and stillbirths. The review found that maternal obesity and adverse maternal risk were positively

correlated. These adverse maternal risks have clearly identified predictors in women with obesity which include pre-existing type I diabetes, age < 20 years old and age > 35 years old, non-white ethnicity, abdominal adiposity obesity, and history of bariatric surgery. The authors recommend screening be done for pregnant women with obesity at their first prenatal appointment. This could help identify complications that may arise and allow for earlier intervention and an improved outcome for both the mother and infant (Fakhraei et al., 2022).

A meta-analysis conducted by Chu et al. (2007) found that the risk of gestational diabetes increased substantially with increases in maternal BMI. The American Diabetes Association Professional Practice Committee states that generally, specific risks of diabetes in pregnancy include spontaneous abortion, fetal anomalies, preeclampsia, fetal demise, macrosomia, neonatal hypoglycemia, hyperbilirubinemia, and neonatal respiratory distress syndrome (American Diabetes Association, 2021). There is also a discussion that diabetes in pregnancy may increase the risk of obesity, hypertension, and type 2 diabetes in offspring later in life (Catalano, 2010).

In addition to weight status at the time of pregnancy, weight gain during pregnancy is an important consideration as well (Golawski et al., 2023). For the purpose of providing guidelines for gestational weight gain during pregnancy, pre-pregnancy BMI is broken into four BMI categories: underweight, BMI < 18.5; normal weight, BMI = 18.5 to 24.9; overweight, BMI = 25 to 29.9; and obese, BMI > 30. Gestational weight gain (GWG) guidance varies by BMI category. The following is the recommended GWG for each BMI category: underweight, 28 to 40lbs; normal weight, 25 to 35lbs; overweight, 15 to 25lbs; and obesity, 11-20lbs (Institute of Medicine, 2009).

Table 1.1

Institute of Medicine (IOM) Gestational Weight Gain in 2009 by Wight Class

Pre-Pregnancy BMI	2009 IOM Standards	
	BMI (kg/m^2)	Total Weight Gain Range (lbs)
Underweight	<18.5	28 – 40
Normal Weight	18.5 – 24.9	25 – 35
Overweight	25.0 – 29.9	15 – 25
Obese (all classes)	≥30.0	11 – 20

These guidelines lead to the question of what is the significance of weight gain during pregnancy? Weight gain occurs due to changes in placental metabolism, maternal metabolism, and maternal physiology (Institute of Medicine and National Research Council, 2009). The weight gained is distributed as follows, "approximately 27% resides in the fetus, 20% includes the placenta, amniotic fluid and uterus, 3% comprises breast weight, 23% is made up of blood volume and extravascular fluid, and the remaining 27% consists of maternal fat stores" (Herring et al., 2012). It seems as though the fat reserves are kept in the hips, backs, and upper thighs of women who are underweight and normal weight. Those who are overweight or obese do not show these same trends. This may be because of a reduced need for reserves for lactation and the postpartum period (Lang & King, 2009). Insulin secretion and sensitivity rise during pregnancy. This creates favorable conditions for increased lipogenesis and fat accumulation. All these things are done for the anticipated increased energy needs of the growing fetus. Nutrients are also stored for anticipated breastfeeding demands once the baby is born (Lain & Catalano, 2007).

Maternal and infant mortality rates in the U.S. are above those in most other high-income countries, and it is important to understand why. (Committee on Obstetric Practice, 2013). Results of this research will add to the limited body of evidence regarding pregnancy weight gain

in individuals with obesity. This increased knowledge could have a significant impact in reduced risk of death for the mother and infant, improved health for the mother and infant, and decreased healthcare burden (Bale et al., 2003). With obesity becoming more common, it is important to know how to reduce the risk of harm coming to either the mother or the infant during pregnancy.

Overall, there is limited and somewhat conflicting data regarding pregnancy weight gain among women with obesity. As such, the purpose of this research is to investigate whether adherence to current pregnancy weight gain recommendations is associated with the best birth and maternal outcomes among women with obesity.

Chapter 2 - Literature Review

The prevalence of pre-pregnancy obesity is on the rise (Driscoll & Gregory, 2020), and this rise is of concern due to the increased risk of gestational complications associated with obesity. Weight gain during pregnancy is an important factor with regard to pregnancy outcomes (Golawski, et al. 2023), and additional research is needed to understand pregnancy weight gain patterns in pregnant women with obesity and the effects of such patterns on maternal and infant outcomes.

Limiting weight gain in pregnant women with obesity has produced mixed results. While some reviews have shown that restricting weight gain does not increase risk of small birth weight, other reviews show higher risk of preterm birth, small-for-gestational-age, and perinatal mortality when compared with women who did not restrict weight gain during pregnancy (Committee on Obstetric Practice, 2013). Most research on the topic of weight loss during pregnancy is focused on how much weight gain a woman with obesity should have during pregnancy (Kapadia et. al., 2015). One systemic review was conducted in 2015 and looked at how weight loss during pregnancy affected the fetus in 2 different areas, small-for-gestational-age, and large-for-gestational-age. Six different cohort studies were included and none of these six studies mentioned whether the rate of preterm birth increased or decreased. The systemic review found that "the odds of infants being small-for-gestational-age ($<10^{th}$ percentile, multivariable) for obese mothers with gestational weight loss compared to gestational weight gain" was increased (Kapadia et. al., 2015). But gestational weight loss was also associated with a decrease in odds of large-for-gestational-age babies. Women with obesity who lost rather than gained weight overall during pregnancy had smaller babies than those who gained the recommended amount of weight or more.

A few studies have shown that the benefits of weight loss for the mother outweigh any risks to the fetus because so many other risks are being decreased. Women with obesity who lost weight during pregnancy were less likely to develop complications with the delivery, such as cesarean section (Kapadia et. al., 2015). With fewer large-for-gestational-age weight infants, risks for those babies of becoming obese, developing high blood pressure, and diabetes decreases. Due to lack of research and some known adverse outcomes, such as small-for-gestational-age babies, the current guidelines recommend that women do not lose weight during pregnancy, even if they are currently obese. This knowledge helps support the thought that all women of child-bearing years should be aware of their weight and know the risks associated with obesity to them and the fetus during pregnancy (Kominiarek et. al., 2017).

A randomized control trial aimed at preventing excessive gestational weight gain among women of all weight categories recruited 110 women before 20 weeks of gestation with singleton pregnancies who agreed to take part in an intervention to keep gestational weight gain within the recommended guidelines. Polley et al. (2022), randomly assigned these women into an intervention group or a standard care control group. The intervention group was stratified by BMI category: normal and overweight and obese. The standard care control group received standard nutrition counseling that was provided by their physicians and nurses. The intervention was delivered by staff trained in clinical nutrition or clinical psychology and included oral instruction in appropriate weight gain during pregnancy, exercise during pregnancy, and healthy eating during pregnancy. Furthermore, newsletters were mailed to the participants in the intervention group biweekly, and after each clinic visit, they would receive a personalized graph of their weight gain. The intervention group participants who remained within the weight gain recommendation were given encouragement to continue healthy eating and exercise and women

who exceeded the recommendations were given additional counseling from the dieticians. There were a few results that came from this study. First, they looked at weight retention at 8 weeks postpartum. Weight retention was strongly correlated with weight gain during pregnancy, but there were no significant differences between the intervention and control group of both normal weight and overweight women. The intervention was found to be effective in reducing excessive weight gain in women with normal weight but was not effective in women with overweight and obesity. The authors note that there were limitations in this study that may have accounted for the intervention not being successful such as a small sample size. Another limitation was that only 62% of the women were available for follow-up postpartum measurements. This may have been because the study focused on women in the low-income population who faced barriers to completing the study (Polley et al., 2002).

Another intervention aimed at minimizing weight gain in women with obesity during pregnancy to less than 7 kg (Claesson et al., 2008). This study included 140 women in the intervention group and 193 women in the control group and monitored them throughout their pregnancy. All women had a BMI that indicated obesity. The intervention group received extra information at their first prenatal appointment about the importance of weight control. They also attended a 30-minute motivation session each week. At this session they were invited to participate in an aqua aerobics class. Results showed that women in the intervention group had lower weight gain than those in the control group. On average, the women in the intervention group had lost weight at their first postnatal appointment compared to their first pregnancy weigh in. Weight gain during pregnancy seemed to be independent of socio-demographic characteristics after adjustments. Some birth outcomes were analyzed between the two groups and then among women who gain less than 7 kg during gestation. There were minimal

differences in birthweight, gestational age, and mode of delivery between the groups and from the women who gained less than 7 kg. This intervention was found to be effective in controlling excessive weight gain without increasing risk in maternal and fetal outcomes.

There is a question whether pre-pregnancy body mass index has greater influence on newborn weight and perinatal outcome than weight control during pregnancy in obese women. To answer this question Zhang et al. (2023) retrospectively looked at 835 pregnant women hospitalized in Beijing between January 2018 – December 2018. The participants were split into two groups: the diet guidance (DG) group (n = 167) and the control group (n = 668). The diet guidance group received nutrition counseling from obstetric dieticians throughout their pregnancies. The DG group had significantly less weight gain in the second and third trimesters of pregnancy. Among the BMI categories underweight, normal weight, and overweight, there was a positive relationships between gestational weight gain (GWG) and birth weight. In the obese category however, there was a negative relationship between GWG and birth weight. In other words, after weight control, the birth weight was higher when the GWG was reduced, which suggests no relationship between GWG and birth weight. “However, when the mean [group] BMI was used, the pre-pregnancy BMI and GWG positively affected the birth weight” (Zhang et al., 2023). This suggests that the higher BMI masks the effects of GWG on birth weight. Restricting or controlling weight gain during pregnancy reduces maternal and fetal complications, but in women with obesity, reducing BMI before pregnancy may present greater influence on the benefits to both the mother and infant.

The timing of pregnancy weight gain can have an impact on the weight of the fetus at birth (Abrams & Selvin, 1995). A study was done with nonobese women who delivered between 1980 and 1990. A total of 2994 pregnancies were included and weight gain measurements from

each trimester were observed. The results found that each kilogram of maternal weight gain in the first, second, and third trimesters were associated with statistically significant increases in fetal birth weight. An important change was seen when there was low maternal weight gain during the second trimester of pregnancy. This suggests that weight gain during the second trimester is related to fetal birth weight, more so than weight gained during the first and third trimesters.

There are effects for the fetuses of women who are obese during pregnancy or have excess gestational weight gain. Some complications that affect the infant include gestational diabetes, still birth, spontaneous miscarriage, fetal growth abnormalities, and increased risk of cesarean delivery (Kominiarek et al., 2017). Different nutrients are believed to be responsible for or to greatly influence different developmental milestones within a growing fetus. Baker et al. (1997) state that, "among intrauterine environmental factors, nutrition plays the most critical role in influencing placental and fetal growth". When certain nutrients are lacking, or above recommended levels, complications during both infancy and later into adulthood can occur. As these infants born to overnourished mothers become adults, the increased health risks largely vary based on the mother's obesity while they were in utero. Some of these health risks include stroke (a higher significance in women than in men), cardiovascular disease, incidence of cancer, obesity, and type II diabetes (Lu et. al., 2001). Research on this topic is crucial for improved maternal and fetal health.

Current nutrition guidelines for pregnancy include energy recommendations per trimester. During pregnancy, a woman's nutritional needs and energy needs change. The calories ingested should increase by approximately 340 kcal per day in the second trimester and 450 kcal per day in the third trimester (National Research Council & Institute of Medicine, 2009). This

value is calculated from an estimate of 80,000 kcal needed to support a full-term pregnancy and takes into account increased maternal and fetal metabolism and fetal and placental growth" (Kominiarek et. al., 2017). These additional 300 calories should come from nutrient-dense foods. Additional nutrient requirements that increase include vitamin A, vitamin D, folate, niacin, riboflavin, thiamin, vitamin B6, vitamin B12, vitamin C, iron, selenium, and zinc.

The most recent guidelines from the Institute of Medicine (IOM) emphasize the importance of normal maternal weight pre-pregnancy and gaining the recommended amount of weight during pregnancy (Rasmussen et, al., 2015). In 1990, the IOM issued guidelines for gestational weight gain. Since then, the proportion of women who are overweight or have obesity increased from 37% to 59.5% in 2007. Because of the dramatic increase in the prevalence of overweight and obesity, the 1990 guidelines no longer served the population and needed to be revised. The IOM noticed that the obesity epidemic was getting worse, and a likely contributor was excessive gestational weight gain. They found that 38% of normal weight women, 63% of overweight women, and 46% of women with obesity gained more than the recommended amount during their pregnancies. Therefore, IOM released new guidelines for weight gain during pregnancy. The committee was required to base its recommendations on published scientific evidence, and they found a limited amount of data for women with obesity (Rasmussen et, al., 2015). The current guidelines were created but continued research needs to be done on the obesity class weight gain benefits and risks. The new recommendations were created with the outcomes of the mother and the child in mind, rather than just the mother. However, limited data was available for the benefits to both mother and infant and further research in this field is also needed.

Pawlak et al. (2015) looked at the effect of race and ethnicity on gestational weight gain and the risks associated with it. This retrospective cohort study took data from live birth certificates in Colorado from the years 2017 – 2010. The variable assessed was gestational weight gain and whether it was inadequate, adequate, or excessive according to the IOM pre-pregnancy BMI guidelines. Results showed that 44.6% of all women in the study gained excessive weight during pregnancy with a majority of those being women with pre-pregnancy overweight or obesity. Compared to non-Hispanic White women, Hispanic women had a 16% decreased risk in excessive gestational weight gain and an 8% increased risk of inadequate gestational weight gain. Compared to non-Hispanic White women, Black women had a 12% increased risk of inadequate gestational weight gain (Pawlak et. al., 2015). This study concluded that better care for minorities in Colorado is needed and the U.S. born Hispanic population needs more support during pregnancy.

A national study looking at racial and ethnic disparities in inadequate or less than recommended gestational weight gain found it differed by pre-pregnancy BMI (Headen et. al., 2015). This retrospective cohort study started following women aged 14 years old. They continued collecting data until the women turned 22. Women self-reported pregnancy and pre-pregnancy and pre-delivery weights. The results found that 44.4% of women gained excessively, 32.5% gained adequately, and 23.1% gained inadequately. Black women were most likely to gain adequate weight, while Hispanic women were more likely to gain less than adequate compared to White women. For women with a normal BMI, Black and Hispanic women were more likely to gain an inadequate amount of weight compared to White women. Among women with an underweight BMI, Black women had a significantly higher risk of inadequate gestational weight gain compared to White women, with Hispanic women not differing statistically. For

women with an overweight or obese BMI, risk of inadequate gestational weight gain did not differ by race and ethnicity. Adjusted risk ratios found no significant risk for excessive gestational weight gain among all three races/ethnicities.

Ro et al., 2019 created a study looking at racial and ethnic patterning of low birth weight, normal birth weight, and macrosomia babies. This cross-sectional study obtained birth information from state birth certificate records in New Jersey for four major racial groups in the area (White, Black, Hispanic, and Asian). They found that compared to White mothers, Asian mothers had the highest relative risk for low-birth weight babies (RR 1.12, 95% CI 1.09-1.16), followed by Black mothers (RR 1.65, 95% CI 1.61-1.70) and Hispanic mothers (RR1.12, 95% CI 1.09-1.16. Compared to White mothers, mothers of the three other racial and ethnic groups all had lower risk of macrosomia babies. Asian women had the lowest relative risk (RR 0.40, 95% CI 0.39–0.42), followed by Black mothers (RR 0.63, 95% CI 0.61–0.64) and Hispanic mothers (RR 0.83, 95% CI 0.81–0.84). The study concluded that the social factors associated with low-birth-weight babies reduce the risk for macrosomia. These risk factors include low maternal education, pre-pregnancy medical conditions (chronic hypertension, diabetes), pregnancy medical complications (gestational diabetes, gestational hypertension, eclampsia), inadequate nutrition, neighborhood deprivation, poor access to health care, chronic stress, tobacco use, and environmental exposures (de Bernabe et al., 2004). The authors noted that while White mothers had the highest rates of macrosomia, they did not have the highest levels of childhood obesity among their children. Hispanic mother's children had the highest levels of childhood obesity even though a majority of them had normal birth weights. More research should be done to find connections between birth outcomes and childhood obesity.

In conclusion, these studies examine the impact of pre-pregnancy obesity and gestational weight gain on maternal and infant health. While limiting weight gain in obese pregnant women has shown mixed results, current guidelines discourage weight loss due to potential risks like small-for-gestational-age infants. Intervention studies suggest structured programs can help control weight gain, but effectiveness varies, especially for women with obesity. Pre-pregnancy BMI appears to have a greater influence on birth outcomes than gestational weight gain alone and racial and ethnic disparities also affect weight gain patterns and birth outcomes. There is a need for further research to refine guidelines and improve maternal-fetal health.

This study will examine the outcomes of gestational weight gain on maternal and infant outcomes. It will look at the impact within different ethnic and racial groups, amongst different weight gain classifications, and smoking groups. Smoking during pregnancy increases risk in infants for sudden infant death syndrome, asthma, stillbirth, low birth weight and future obesity (Avşar et al., 2021). The study will see if a combination of inadequate or excessive gestational weight gain compounded with smoking intensifies infant and maternal risks.

Chapter 3 - Methods

Through an agreement with the Kansas Department of Health and Environment (KDHE), data was obtained from state-wide certificates of live birth for the years 2014-2019. Using certificate data, pre-pregnancy BMI was determined by height and pre-pregnancy weight. Only individuals with a pre-pregnancy BMI > 30 were selected. Weight gain during pregnancy was then calculated by subtracting pre-pregnancy weight from weight at delivery. Pregnancy weight gain was compared to the recommended weight gain for women with obesity (i.e. 11-20 lbs.) and classified as 1) less than recommended, 2) recommended, 3) more than recommended. Pregnancy outcomes (low birth weight, preterm birth), maternal outcomes (gestational diabetes, gestational hypertension, eclampsia), and delivery method (vaginal vs cesarian) were compared across the three groups, 1) less than recommended, 2) recommended, 3) more than recommended. In addition, pregnancy outcomes, maternal outcomes, and delivery methods were compared by smoking status.

Using SPSS we calculated the Relative Risk (RR) with 95% confidence interval for all demographic groups and birth and maternal outcomes. compared across maternal race/ethnicity groups (White non-Hispanic, Black non-Hispanic, and Hispanic) and smoking status categories. Then within each race/ethnicity group and each smoking status category, pregnancy outcomes, maternal outcomes, and delivery method were compared across the three pregnancy weight gain groups.

Data was provided as summary tables by KDHE. Using the summary data, RR with 95% confidence intervals for each outcome were calculated for all pregnancy weight gain groups as well as all other maternal groups. When calculating RR, the recommended weight gain group,

the non-smoking group and White non-Hispanic mothers were considered the reference group. IBM SPSS version 29.0 (Armonk, NY) was used to calculate all RR and 95% CIs.

Chapter 4 - Results

Table 4.1 contains summary data with relative risks and 95% CIs for pregnancy outcomes, maternal outcomes and delivery type by racial/ethnic category. The analyses for each outcome included 56,980 - 57,145 records of live birth. Among this sample, 54.8% of the women gained more than recommended.

Table 4.1

Relative Risk of Gestational Outcomes by Maternal Race and Ethnicity

	Mother's Race and Ethnicity			
	Black non-Hispanic		Hispanic	
Gestational Outcomes	Relative Risk Compared to White non-Hispanic	95% Confidence Interval	Relative Risk Compared to White non-Hispanic	95% Confidence Interval
Weight Gain Classification				
Less than recommended	1.06	1.02 – 1.11	1.02	0.98 – 1.05
More than recommended	0.98	0.96 – 1.00	0.93	0.91 – 0.94
Obstetric Estimate of Gestation				
Preterm	1.22	1.12 – 1.28	0.96	0.91 – 0.99
Mother Morbidity				
Gestational diabetes	0.78	0.70 – 0.85	1.23	1.17 – 1.30
Pregnancy induced hypertension	0.86	0.78 – 0.93	0.67	0.62 – 0.71
Birth Weight				
<2500 grams	2.12	1.94 – 2.32	1.01	0.92 – 1.10
≥2500 grams	0.94	0.93 – 0.95	1.00	0.99 – 1.00
Method of Delivery				
C-section	0.99	0.96 – 1.03	0.87	0.84 – 0.89
Vaginal	1.00	0.98 – 1.03	1.09	1.08 – 1.11

Summary data with relative risks and 95% CIs for pregnancy outcomes, maternal outcomes, and delivery type by weight gain classification are given in Table 4.2. The analyses for each outcome included 59,920 – 59,937 records of live birth. Among this sample, 39.4% delivered via cesarean section.

Table 4.2

Relative Risk of Gestational Outcomes by Gestational Weight Gain Classification

	Weight Gain Classification			
	Less than Recommended		More than Recommended	
Gestational Outcomes	Relative Risk Compared to Recommended Weight Gain	95% Confidence Interval	Relative Risk Compared to Recommended Weight Gain	95% Confidence Interval
Obstetric Estimate of Gestation				
Preterm	1.10	1.04 – 1.14	0.93	0.90 – 0.97
Mother Morbidity				
Gestational Diabetes	1.20	1.12 – 1.27	0.79	0.75 – 0.83
Pregnancy Induced Hypertension	0.90	0.83 – 0.97	1.32	1.25 – 1.40
Birth Weight				
< 2500 grams	1.35	1.24 – 1.47	0.66	0.61 – 0.72
Method of Delivery				
C-section	0.95	0.92 – 0.98	1.07	1.05 – 1.10

Table 4.3 and 4.4 contains summary data with relative risks and 95% CIs for pregnancy outcomes, maternal outcomes and delivery type by smoking status. The analyses for each outcome included 60,098 – 60,115 records of live birth. Among this sample, 19.3% delivered premature infants. See Tables 4.3 and 4.4.

Table 4.3

Relative Risk of Gestational Outcomes of Smokers Compared to Nonsmokers

Risk Factors	Relative Risk of Smokers Compared to Non-smokers	95% Confidence Interval
Obstetric Estimate of Gestation		
Preterm	1.06	1.01 – 1.12
Birth Weight		
<2500	1.44	1.32 – 1.58
Method of Delivery		
C-section	1.09	1.01 – 1.12

Table 4.4

Relative Risk of Gestational Outcomes amongst Smokers by Weight Gain Classification

	Less than Recommended		More than Recommended	
	Relative Risk of Smokers Compared to Weight Gain Classification	95% Confidence Interval	Relative Risk of Smokers Compared to Weight Gain Classification	95% Confidence Interval
Gestational Diabetes	0.99	0.83 – 1.12	0.89	0.75 – 1.05
Pregnancy Induced Hypertension	0.82	0.65 – 1.03	1.29	1.07 – 1.55
Eclampsia	1.35	0.55 – 3.30	1.40	0.63 – 3.11

Summary data with relative risks and 95% CIs for pregnancy outcomes, and maternal outcomes by racial/ethnic category and weight gain classification. Among this sample, 12.2% developed gestational diabetes. See Table 4.5.

Table 4.5

Relative Risk of Gestational Outcomes by Race/Ethnicity and Weight Gain Classification

	Weight Gain Classification			
	Less than Recommended		More than Recommended	
Gestational Outcomes	Relative Risk Compared to Recommended Weight Gain	95% Confidence Interval	Relative Risk Compared to Recommended Weight Gain	95% Confidence Interval
Gestational Diabetes				
White non-Hispanic	0.97	0.96 – 0.98	0.75	0.70 – 0.80
Black non-Hispanic	1.05	0.81 – 1.02	0.96	0.76 – 1.20
Hispanic	1.26	1.10 – 1.42	0.88	0.78 – 0.99
Pregnancy Induced Hypertension				
White non-Hispanic	0.88	0.80 – 0.96	1.25	1.17 – 1.34
Black non-Hispanic	1.08	0.83 – 1.40	0.96	0.76 – 1.20
Hispanic	0.83	0.68 – 1.03	1.44	1.23 – 1.69
Eclampsia				
White non-Hispanic	0.75	0.49 – 1.16	1.04	0.75 – 1.44
Black non-Hispanic	n/a	n/a	1.36	0.54 – 3.41
Hispanic	1.27	0.54 – 2.98	1.10	0.50 – 2.27
Low-Birthweight				
White non-Hispanic	1.27	1.14 – 1.42	0.62	0.56 – 0.69
Black non-Hispanic	1.51	1.23 – 1.87	0.79	0.65 – 0.97
Hispanic	1.41	1.16 – 1.73	0.71	0.58 – 0.87

Chapter 5 - Discussion

The aim of this research was to investigate whether adherence to current pregnancy weight gain recommendations is associated with the best birth and maternal outcomes among women with obesity. Pre-pregnancy weight and gestational weight gain (GWG) are critical factors influencing maternal and infant health outcomes. In women with obesity, the impact of GWG is particularly significant due to pre-existing health risks and the potential for pregnancy-related complications. The research found that gaining below or above the current recommended weight gain recommendation can increase risk for certain morbidities.

Compared to mothers who gained the recommended amount of weight during pregnancy, mothers who gained less than recommended had a higher risk of developing gestational diabetes and those who gained more than recommended had a lower risk of developing gestational diabetes. This result was surprising as other studies suggest that excessive GWG is associated with the development of gestational diabetes (Carreno et al., 2013), (Hedderson et al., 2010). This may be because excessive early GWG could be associated with an early increase in insulin resistance. This would lead to exhaustion of the pancreatic B cell. The B cell depletion could reduce the ability for the cell to compensate for the increasing insulin resistance of pregnancy. This could lead to hyperinsulinemia, maternal hyperglycemia or excessive fetal growth (Herring et al., 2009), (Hedderson et al., 2010). These studies included women with varying BMI, and more studies should be done to examine the relationship between excessive GWG in women with obesity, and the onset of gestational diabetes.

Compared to mothers who gained the recommended amount of weight during pregnancy, mothers who gained less than recommended had a lower risk of developing pregnancy induced

hypertension and those who gained more than recommended had a higher risk of developing pregnancy induced hypertension (RR 1.32, 95% CI 1.25 – 1.40).

Compared to White non-Hispanic mothers, Black non-Hispanic mothers and Hispanic mothers were less likely to gain more than recommended and Black non-Hispanic mothers were more likely to gain less than recommended. Similar findings are found in current research (Headen et. al., 2015), (Pawlak et al., 2015). Generally, White non-Hispanic mothers are more likely to gain excessive gestational weight compared to Black non-Hispanic and Hispanic women. This could be due to socioeconomic factors, cultural factors, biological factors, or access to healthcare. Higher socioeconomic status can sometimes correlate with greater food security, leading to overconsumption rather than undernutrition. Some cultures may encourage maintaining a controlled weight during pregnancy, while others may view eating more during pregnancy as a sign of health. White non-Hispanic women may consume more processed and high-calorie foods compared to Hispanic and Black women, who may have traditional diets that are lower in refined sugars and unhealthy fats.

The IOM provides specific GWG guidelines for women with obesity, recommending a total gain of 11-20 pounds (National Research Council & Institute of Medicine, 2009). This study found that adherence to these guidelines can help manage risks for both mother and child. Recommendations for staying within these guidelines would include nutritional counseling, regular physical activity, and close monitoring by healthcare providers. Interdisciplinary care involving obstetricians, dietitians, and fitness experts can help women achieve optimal weight gain and improve pregnancy outcomes (Kominiarek & Peaceman, 2017). Psychological support and stress management techniques may also be beneficial in promoting healthier behaviors and addressing emotional factors influencing weight gain (Kominiarek et al., 2018)

Strengths and Limitations

The use of Kansas Department of Health and Environment (KDHE) birth certificate data was a strength, ensuring a large, population-level dataset and increasing the generalizability of the findings. Weight gain categories are based on IOM recommendations for obese women, ensuring comparability to other research. The study examines multiple maternal and infant outcomes, including birth weight, preterm birth, gestational diabetes, hypertension, and delivery method, providing a holistic view of how gestational weight gain impacts health. The use of RR and confidence intervals allows for a clear interpretation of risk differences across groups. Comparing weight gain and outcomes across racial/ethnic groups and smoking status provides insight into potential disparities in maternal health.

One limitation of the study is that it did not include all ethnic groups (e.g., Asian women). An additional limitation was the lack of information on dietary habits, physical activity levels, access to healthcare, stress levels, and socioeconomic status (SES), all of which may influence gestational weight gain and outcomes. Differences observed across racial/ethnic groups may be due to SES disparities rather than inherent biological differences when comparing different racial and ethnic groups. Findings may not be applicable to other states or populations with different healthcare systems, demographic compositions, or public health policies. Using White non-Hispanic mothers, non-smokers, and the recommended weight gain group as the reference may introduce bias if these groups differ significantly in ways not accounted for in the analysis. Lastly, the cross-sectional nature of the study prohibits causal conclusions.

Conclusion

Managing GWG in women with obesity is essential for minimizing health risks and promoting favorable outcomes for both mother and child. In this study, the majority of women

with obesity gained weight in excess of the guidelines. Tailored interventions and adherence to established guidelines can significantly reduce the incidence of pregnancy-related complications and contribute to long-term health benefits. Ongoing research is necessary to refine GWG recommendations and develop targeted strategies that address the unique needs of pregnant mothers with obesity. Increased awareness and education on the implications of GWG can help women to make informed decisions, and lead to healthier generations.

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