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Impact of Maternal Obesity on Pregnancy, Birth, and Infant Outcomes

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Abstract

The purpose of this research study is to investigate how maternal obesity impacts pregnancy, birth, and infant outcomes. Maternal obesity is related to the development of many chronic diseases, delivery complications, adverse infant outcomes, and can be a predictor of postpartum weight retention that can lead to an increase in female obesity statistics. Authors utilized the PubMed.gov site to locate reference studies using obesity, maternal outcomes, infant outcomes, and breastfeeding as variables. Data from Wisconsin Interactive Statistics for Health (WISH) and from a community hospital in southeast Wisconsin between 2014-2016. These data included body mass index (BMI), weight gained during pregnancy, number of births, and infant mortality. Variables were analyzed using race, ethnicity, and year of birth. The data includes the percentages of women who developed hypertension or diabetes during pregnancy and whether they had spontaneous or assisted methods of delivery like Cesarean-section. This urban community has high rates of infant mortality among African Americans. Our data demonstrates that more African American women experience preterm birth and death of their infant during their first year of life. This is important because it highlights the health disparities within the US and how it effects vulnerable populations like pregnant women and infants. Excessive weight gain in women that are overweight or obese can lead to potentially negative pregnancy, birth, and infant outcomes. Weight gain throughout pregnancy is a modifiable risk factor and if gained in amounts as recommended for their pre-pregnancy BMI, this reduces the risk of diabetes, hypertension, assisted methods of delivery, and large for gestational age (LGA) babies. Public health strategies should be utilized to educate woman and provide resources on how to manage weight gain during pregnancy to increase the incidence favorable maternal and infant outcomes.

Keywords: Maternal and Child Health, Obesity, Life Course Perspective

1. Background and Introduction

Health promotion across the lifespan, specifically women and children, is important for the health of all people. Education should be provided about how to maintain health (physical, emotional, and mental) and needed to create healthy offspring. Creating and maintaining healthy behaviors is the key to increasing healthy outcomes for every population. The United States (US) is a mixture of cultures and traditions. One tradition that is consistent across most in America is the *eating for two mentality* that pregnant women believe they need to eat beyond their metabolic needs. Although an increase in nutrition dense foods is needed to promote the growth of a healthy offspring, energy dense foods are craved, and their consumption is promoted. This overconsumption can lead to unneeded weight gain that can last post-delivery and increase the percentage of childbearing age women who are overweight and/or obese.

Between 2015 and 2016, 93.3 million (39.8%) of adults in the United States were obese according to their body mass index.[1] Having increasingly high numbers of overweight and obese individuals in the United States increases the risk for individual and population health risk of heart disease, strokes, type 2 diabetes, and many different types of cancer. Obesity-related conditions can impact all aspects of a person's health, especially if they are pregnant or trying to conceive. Often, conditions such as heart disease, stroke, type 2 diabetes and cancer are thought to be genetic, when individual risk is increased by overconsumption and/or inactivity. Having a larger body size increases the

development of chronic conditions that lead to increased hospital visits and stays, and ultimately increased health care costs. In the US, many people do not have access to healthcare because of socioeconomic reasons or social determinants of health, which may contribute to poorly controlled chronic conditions.

In addition to the high number of individuals who are overweight and obese, the US has a higher infant mortality rate than most developed nations. Wisconsin's rate of infant mortality was 6.8 in 2017.[2] As a country, the infant mortality rate was 5.8 deaths per 1,000 live births. Though this issue has been addressed with an intervention in the Healthy People 2020 objectives, the infant mortality rate for non-Hispanic African American babies is double to that of European American babies. In 2016, the infant mortality rate was 11.4 for non-Hispanic African American babies as compared to the 4.9 rate for non-Hispanic European American babies. Though infant mortality rates can be addressed by discussing interventions related to diet, exercise, and sex education, discussing institutional racism within the US healthcare system is an integral part of this systemic problem.

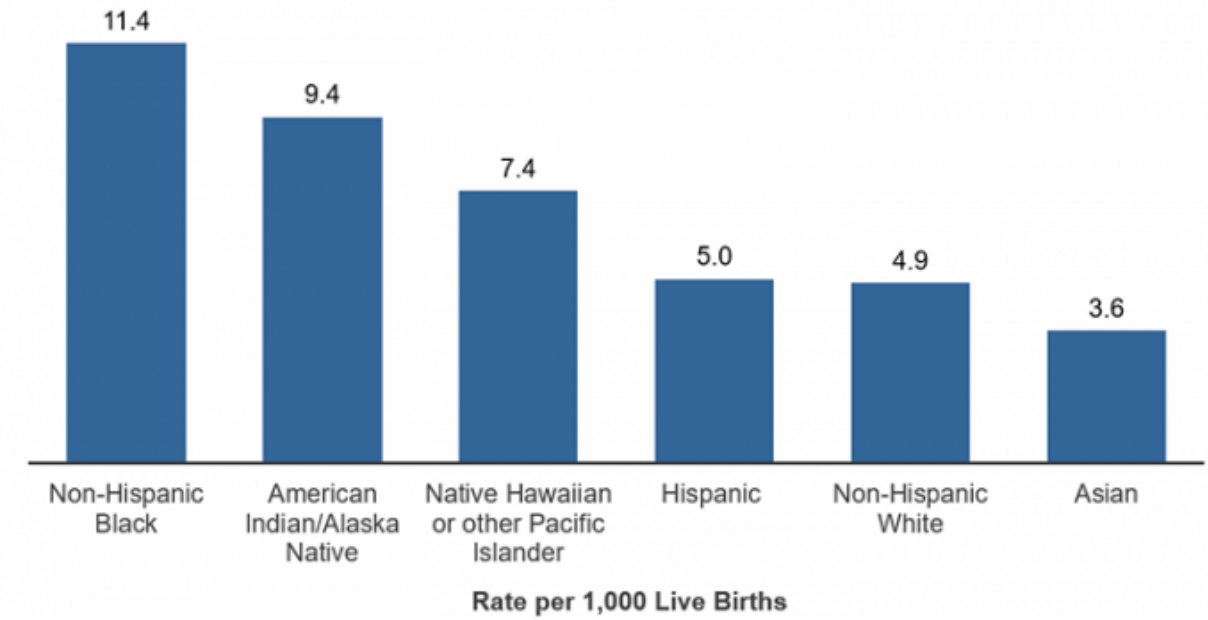

Figure 1: Infant Mortality Chart for the United States in 2017 from the Centers for Disease Control and Prevention, separated by race and ethnicity.[1] Chart shows the number of children that die under the age of a year per 1,000 live births.

1.1 Purpose of Study

The purpose of this study is to compare maternal, birth, and infant outcomes of women who are normal, overweight, and obese by race/ethnicity. The secondary purpose is to provide information on how both pre-pregnancy size and excessive weight gain can negatively impact pregnancy, birth, and infant outcomes.

1.2 Literature Review

An article titled "*Improving Maternal and Child Health Across the Life Course: Where Do We Go from Here",* Lu wrote about how life-course intervention research specifically looks at moving from discovery to intervention-based research. [3]Life-course research should include details on costs, number of interventions, timing, and how data could be collected. It addresses how life-course research should have more of a collective impact regarding maternal and child health topics. One of the interventions that Lu mentions is "early and preemptive interventions" to address issues that can be prevented or minimized by intervening prior to the problem(s) being already there (i.e. the prevention of child obesity by establishing prenatal nutrition or limiting adverse birth outcomes by intervening during a child bearing age woman's preconception health). Next, Lu addresses "multilevel, cross-sector intervention" by establishing a "whole-person, whole-family, whole-community systems approach" that would include variables such as education, poverty, relationship between fathers and families, housing, and lifelong racism, or social determinants of health.

Lastly, the "multidimensional systems integration" that is needed to reach varying groups such as education, economic and community development and care throughout the lifespan. Lu addresses maternal and child health working through various siloes (age, disciplines, data, etc.) how these group designations can be isolating and that many current issues can be remedied by using a more collaborative approach. The Affordable Care Act's (ACA) impact is discussed and Lu mentions that the number of women that do not have access to health care will be reduced and copay prices will be reduced or removed for preventative services. With that in mind, the ACA contributed to the improvement of women's health throughout the lifespan. Dr James Heckman's book "*Giving kids a fair chance*" is briefly included in the article and he explains how success in America is dependent on cognitive skills, non-cognitive skills, and health during early childhood.[4] He explains that have these skills is contingent on levels of toxic stress and nurturing because these environments can impact gene expression and cause developmental brain disruptions.[3] Lu explains that children cannot be solely responsible for their own health and proposes an intervention that would include the environment in which young children spend most of their time in (home, child care, and health care). These settings could be included when prioritizing the health of children in lower socioeconomic status households and neighborhoods.

Lu wrote that in order for Maternal and Child Health to continually evolve, it needs to be provided in an interdisciplinary manner.[5] Technological advancements can aid prenatal care's evolution by collecting more accurate data on "blood pressure, urine protein, nutrition and physical activities, stress and sleep, occupational and environmental, and other exposures that truly matter to pregnancy outcomes and developmental origins of health and disease". The data could then be transferred and used to inform routine follow-up visits and phone calls from providers. Technological advancements can further inhibit maternal and child health evolution by providing differential access to families. Big data has the possibility of aiding maternal and child health outcomes by influencing collaborative efforts between providers, researchers, families, and volunteers. When large groups of health care professionals work together to improve social conditions, increase access and lower social inequality, there is a strong potential for improving outcomes in maternal-child health. Climate change, infectious outbreaks, antimicrobial resistance, chronic diseases, and decaying infrastructure can limit the progress of maternal and child health. Through collaboration, health care providers can work to lessen the negative impact so that positive change is possible.[5]

In the article, "*Closing the Black-White Gap in Birth Outcomes: A Life-Course Approach"* Lu, et. al explains that the United States' racism towards African Americans has led to poor birth outcomes for African American infants.[6] Differential access and quality of pre- and interconception care, prenatal care, and healthcare across the lifespan puts African American mothers at a disadvantage as compared to European American mothers.[6] Other factors that can contribute to positive health outcomes include father involvement, community building, reproductive social capital, and systems integration in the form of an intervention. Lu, et. al discusses how closing the education gap, reducing poverty, supporting working mothers, and working to undo racism within the United States could lessen disparities and give African American infants the same chances as European American infants.[6]

Catalano and Shankar explain that obesity can disrupt the hypothalamic-pituitary-ovarian axis and cause women who are overweight to have shorter luteal phases and lower levels of follicle stimulating hormone, luteinizing hormone, and progesterone.[7] Oocyte development can be hindered by obesity because of the changes in the follicular fluid that encases the oocyte and granulose cells. It can also disrupt gene expression during the luteal phase, this points to obesity contributing to reproductive dysfunction.[7] Women who are obese or overweight have a higher risk of spontaneous miscarriages and congenital abnormalities in offspring. Obesity can cause the placenta to be heavier and have an increased amount of lipids**.** It can also lead to spontaneous preterm birth, metabolic dysfunction like gestational diabetes mellitus and pre-eclampsia, failed trial of labor, anesthetic complications, cesarean delivery, endometritis, neonatal injury, wound disruption, postpartum venous thromboembolism and pulmonary embolism, decrease in first phase of milk production, and postpartum depression. Neonatal complications of babies born of mothers who are obese include high concentrations of leptin and interleukin 6 (IL-6) in the umbilical cord and greater insulin resistance than babies born of mothers who were not obese. Childbearing in women who are obese can lead to gestational weight gain that can cause increased postpartum weight retention. Babies who are large for gestational age have an increased risk of being obese during adolescence and adulthood. In addition, children who are large for gestational age and obese during childhood have double the risk to develop insulin resistance.[7]

Kominiarek and Peaceman found that women who were overweight (BMI 25-29.9kg/m2) and obese (class I, BMI 30-39kg/m2) had the highest incidence of excessive gestational weight gain. Racial-ethnic variances in weight of childbearing age women point to higher instances of Hispanic and African American women starting pregnancy as overweight but having inadequate gestational weight gain.[8] Women who are pregnant for the first time tend to gain more weight than women who have had multiple pregnancies. WIC (Supplemental Nutrition Program for Women, Infants, and Children) or Medicaid participation, first-trimester prenatal care, alcohol consumption during pregnancy, prepregnancy depression, and partner abuse were not associated with excessive gestational weight gain.[8] Inadequate weight gain was associated with increased odds of infant death up to one year after birth and failure to initiate breast

feeding.[8] Excessive gestational weight gain can lead to an increased risk gestational diabetes, cesarean delivery, postpartum weight retention, that increases the risk of type 2 diabetes, cardiovascular disease, and metabolic syndrome. Neonatal risks from excessive gestational weight gain include macrosomia, low 5-minute Apgar scores, seizures, hypoglycemia, polycythemia, meconium aspiration syndrome, and childhood overweight and obesity.

Marchi, et. al created a systematic review of reviews to analyze the risks associated with obesity during pregnancy. Gestational diabetes mellitus development was four times higher with women who were obese and nine times higher with women who had severe obesity, as compared to women who were within a normal body mass index category. There is an increased risk of pre-eclampsia and hypertension. Women who are obese may be 3 to 10 times more likely to have pre-eclampsia than normal-weight women and 4.5-8.7 times more likely to have gestational hypertension. There is an increase in cesarean section delivery and instrumental vaginal birth in women who are obese, and this link is suggested to be because of cholesterol deposits in the myometrium of women who have obesity, this affects contractions. This increased risk of cesarean section delivery and instrumental vaginal birth could also be from an increase in maternal soft tissue that is inside of the pelvis that is causing it to narrow the birth canal and leads to difficult birth for large for gestational age babies and a poor response to oxytocin administration.[9] There is an increased risk of antenatal and post-natal depression in women who are obese as compared to women that have a healthy weight. There is a 33% higher risk of preterm birth with women who have a body mass index at or above 35kg/m2.[9] There is conflicting evidence on whether there is a link between pre-pregnancy obesity and a decreased risk of low birth weight and an increased risk for large-of-gestational-age babies. A lower instance of gastroschisis was found in mothers who were obese. Women who are obese have an increased risk of cardiac defects, that could be caused by lower levels of folic acid, hyperglycemia, and undiagnosed diabetes. Obesity during pregnancy was found to increase the risk for maternal comorbidities that can lead to miscarriage and stillbirth. Obesity was also found to have a relationship with neonatal/perinatal death in singleton pregnancies.[9] Women who are obese were found to have a higher risk of post-partum hemorrhage and increased duration of hospital stay, increased rates of labor induction, frequent use of oxytocin augmentation and higher instances of failure to progress in labor as compared to women with a healthy weight.[9] Women who are obese were found to be less likely to initiate breastfeeding and if they do breastfeed, it is for a shorter duration.

In the article" *The Association of Maternal Pre-Pregnancy Body Mass Index with Breastfeeding Initiation"* by Thompson, et. al. Normal and overweight women had higher rates of breastfeeding initiation than underweight and obese women. Further research needs to be done to analyze gestational weight gain breastfeeding initiation.[10]

2. Conceptual Framework

The Life-course model was used as a framework for this study. This model provides a reference of how events that occurred during previous generations may impact a present or future pregnancy, birth and infant. The Life-course model provides a historical perspective, which is very important as Southeastern Wisconsin has some of the highest rates of African American infant mortality and disparities in the country. This perspective highlights and includes all parts of a woman's life to reduce smoking and alcohol consumption, but also seeking to improve social, economic and cultural factors that increase the risk of unhealthy birth outcomes.[11]

In 2013, a life-course initiative for Wisconsin, specifically the Southeastern area, that addressed not only how the socioeconomic status impacts pregnancy outcomes, but also racism, pre, inter, and post-conception care, quality of prenatal care, healthcare access, father involvement in African American communities, family support services, community building, and the education gap.[11] Researchers created a plan to integrate a collaborative effort that would involve strategic leadership, buy-into the community action plan, address community and environmental level change, and leverage resources".[11] The life-course perspective was then implemented through the Wisconsin Partnership Program of the UW School of Medicine and Public Health Program of the UW School of Medicine and Public Health to reduce racial disparities in birth outcomes. 500 people participated in a two-year period in four of the Wisconsin cities. The concluding ideas of this program created improvements to address the racial birth outcome disparity by "challenging public assumptions on the root cause of poor birth outcomes, leading to support for more integrated approaches focused on the social and physical environment".[11]

3. Methods

The data that was analyzed for this study was collected from a single hospital from Southeastern Wisconsin between the years of 2013 and 2017. Data from 6418 live births between 1/1/2012 and 12/31/2017 using Peridata.net®. The data was reflective of the community and included a wide range of BMI groups, weight gain amounts (normal, less than, more than recommended), race (European American, African American, other), and ethnicity (Hispanic or non-Hispanic). The variables that were analyzed from the data are diabetes, gestational diabetes, hypertension, chronic hypertension with postpartum superimposed preeclampsia with severe features, birthweight (low and very low), length of term, age, race, and weight gain amounts. Wisconsin Interactive Statistics for Health Data was used to see if there was a relationship between obesity, body mass index, weight gain during pregnancy, number of births, and infant mortality in this community. The variables were also analyzed using race and ethnicity by year.

4. Results

The results show that women who have had previous pregnancies are more likely to be obese and overweight than women who were pregnant for their first time. A significant number of women with diabetes mellitus and hypertension were overweight and obese. 4.2% of women who were overweight or obese had very-low birthweight infants due to associated comorbidities. There was no significant difference between full term and pre-term rates when comparing normal, overweight and obese BMI categories. Of all women who are overweight and obese, 64.7% are white compared to 77.1% of white women in the normal BMI category. 55% of women who are classified as overweight or obese gained more than the recommended weight compared to 39.3% of women in the normal BMI category.

Table 1: Data summarizing interpregnancy and/or postpartum complications and birth outcomes.

Variables	**Normal BMI**	**BMI 2G***	**Chi-Square**
	N (%)	N (%)	
Diabetes	9 (0.3)	110 (2.1)	0.000
Gestational Diabetes Mellitus	94 (3.2)	465 (9.1)	0.000
Hypertension	25 (0.8)	224 (4.4)	0.000
Chronic Hypertension with Preeclampsia	0 (0)	3 (0.1)	0.195
Very Low Birthweight	90 (3.0)	217 (4.2)	0.007
Term	702 (23.7)	1167 (22.8)	0.921
Age	223 (7.5)	489 (9.5)	0.000
	1162 (39.3)	2816 (55)	0.000
BMI 2G* = Overweight and Obese women, gain more than recommended			
Race	European American	African American	Chi-square
% Obesity	59%	72%	0.000

Figure 1: Chart describing percentages of women who experienced interpregnancy and/or postpartum complications and birth outcomes depending on normal BMI and BMI 2G (women who are overweight and obese and/or women that gained more than recommended). In addition, the chart also includes the percentage of obesity in pregnant women depending on race.

4.1 Logistic Regression

The odds ratios of conditions predicting a pre-term birth were calculated from 6418 live births occurring between the years 2013 and 2017. The dependent variable which indicates a preterm was coded as 1 while the full-term births were

coded as 0. The Omnibus Test of Model Coefficients was significant indicating a model fit (χ^2 (4) =29.56, p<.001). The final block predicted time of birth (preterm 14%/ fulltime 97%) correctly 77.7 % of the time. The most significant predictors in the model were hypertension OR = 4.05 (3.42-4.81) Diabetes OR=1.63 (1.32-2.02) and weight gain more than recommended OR=2.22 (1.91-2.58).

5. Discussion

The United States is composed of many different cultures that perpetuate the idea that women can consume excess calories during their pregnancies because they are now eating for two. This idea can be a contributing factor overweight and obesity among women of childbearing age.

According to the data from this study, pregnant women who have a BMI that is overweight or obese, are more prone to have gestational diabetes mellitus, hypertension, and they produce offspring that are in the very low birthweight category. 39.8% of adults in the United States are obese or overweight. In the United States, America's Health Ratings found that 17.5% of women between the ages of 18 and 24, 28.1% of women between the ages of 25-34 and 32.3% of women between the ages of 35 and 44 are obese.

Public health interventions that aim to target women in the childbearing ages of 18-44 could have a strong impact on the obesity statistics in the United States because these interventions would give women an education-based foundation for weight management and healthy living tips that could be utilized well past pregnancy. This could lower the obesity statistics as the age population increases beyond childbearing years.

Reducing the BMI of women who are obese or overweight prior to pregnancy could also lower the number of women who enter or leave pregnancies with an overweight or obese BMI. Educating women on weight management, healthy eating, ways to stay active, and appropriate weight gain and consumption of nutrient dense food during pregnancy could positively impact on the health of women throughout the lifespan and contribute to healthier outcomes for their offspring.

The results from this study show that 72% of women who were African American and 59% of women who were European American were overweight or obese. During pregnancy, it is not advised to begin a weight loss plan, but advice can be given to women prior to becoming pregnant on how to stay active, consume nutrient dense foods, and stress management to provide women with education that could lower their weight gain closer to recommended values for their pre-pregnancy BMI.. Often women receive advice that cannot be followed because of limited finances, time, or other variables, including social determinants of health that could hamper their ability to follow through. Alternate advice that tailors recommendations to their personal situations should be provided so that women in all situations can still experience positive results.

6. Strengths and Limitations

The population in the data set was reflective of the community that it represented. Women of varying ages, body mass indexes, and other variables are represented within the data that allow researchers to create interventions that can reach women across the United States. There were a few limitations in this study, howeverthe data was collected in a relatively small area in Southeastern Wisconsin. The target area could be expanded to include more women in different areas of the US. Understanding that southeastern Wisconsin is a significant place for African American infant mortality, different interventions that could promote the health of women and infants should be included. For future studies, it could be of interest to pay attention to the segregated cities in the US to analyze how physician or health care providers administer interventions depending on the population being served. This could unearth the stark difference between European American and African American infant mortality statistics. It is an understatement to say that racism is integrated into every aspect of life in the United States.

7. Conclusion

Women in the United States are connected by the theme of overconsumption and inactivity during pregnancy. This understanding leads to higher amounts of women that are obese or overweight during or following their pregnancies and this could lead to the development of chronic diseases like diabetes and hypertension that can last throughout the lifespan and increase the risk of delivery of high-risk offspring.

Education prior to a woman becoming pregnant could increase the chances of her gaining the recommended weight during pregnancy based on pre-pregnancy BMI, and decrease her risk to develop chronic diseases development, and increase the likelihood of delivering a healthy weight baby.

Integrated racism and discrimination is and has always been rampant in the United States. When analyzing the infant mortality statistics for African American children, the disparities that exist by race is evident. Having healthcare providers who have the cultural intelligence to not allow biases, stereotypes, or other limitations to hinder their quality of care could lower the infant mortality for African American children.

8. Acknowledgments

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