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Effects of Maternal Obesity on Preterm Birth and Birthweight

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2019

Abstract

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MBA, Norwich University, 2009

BS, University of Tampa, 2001

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Obesity is one of the major risk factors for neonate low birthweight among reproductive women. The purpose of this quantitative study was to examine the association between 3 categories of obese status (moderate, severe, and very severe) and low neonate birthweight and preterm birth among women ages 18 to 39 years at all socioeconomic levels. Secondary data were obtained from 141,859 women ages 18-39 years living in the United States who had participated in the 2012-2015 Pregnancy Risk Assessment Monitoring System. Social-ecological theory was used to guide the study, and binary logistic regression was used for the analyses adjusting for age, education, ethnicity, income, marital status, and race confounders. Without accounting for the confounders, moderate, severe, and very severe obesity were associated with preterm birth. However, after adjusting for confounders, the obese categories were no longer associated with preterm birth. The estimated prevalence of preterm birth was higher among moderate, severe, and very severe obesity categories combined (56 preterm births per 1,000 live births) than among normal weight women (43 preterm births per 1,000 live births). Women of moderate obesity had a 10% statistically significant higher odds (p = .046, *OR* = 1.095) of neonate low birthweight when compared with very severely obese women. Severely obese women were not associated with neonate low birthweight when compared to women with very severe obese status (p = 0.159, *OR* = 1.056). Findings may be used to promote healthy lifestyle changes that could reduce the prevalence of preterm birth among obese women.

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Dedication

This dissertation is dedicated to my number one support team: my husband, Terry, and sons, Noah and Micah, and my daughter Milan. Thank you so much for being patient during times of isolation and frustration, for drying my tears, for saying it is okay you can do it, and for believing in me. Thank you to my parents for always being supportive through encouragement, motivation along this journey and continuing to mentor and serve as my positive role models. I also extend my gratitude to my close friends for understanding and being a great support system throughout this dissertation process. Thank you, everyone!

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I can say this has been the most intense period of my life and a journey I will never forget. Through the long days and nights, mental breakdowns, adrenaline rushes, and mixed emotions, I made it and would not have done it without God and prayer. Second, I would like to thank my support and mentor team: Chair Dr. Tschida, Committee Member Dr. Oliphant, and the University Research Reviewer Dr. Tabung. I appreciate all of your constructive criticism, patience, and support during this dissertation process. Last but not least my mentor and friend, Dr. Omelu. They say people come into your life for a reason, and without your motivation and mentorship, I do not know where I would be. Thank you very much, everyone!

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Chapter 1: Introduction to the Study

The purpose of this study was to assess the effects of three maternal obese statuses (moderate, severe [very obese], and very severe conditions) on preterm birth and neonate birthweight. Understanding the factors influencing weight loss in women of childbearing age is essential in obstetric interventions and can contribute in public health areas of health promotion, preventative care, and the advancement of effective health promotion and preventative measures among the identified population as it relates to birth and neonate birthweight. Among women and health practitioners, pregnancy planning and gestation period are critical aspects of parturiency (Smith, 2007). The gestation period is the time when the fetus is developing, and the woman's body is undergoing some physiological and physical changes (Leddy, Power, & Schulkin, 2008). Gestation is also the period that, if not properly managed and cared for, could pose short- and/or long-term adverse health risks for both the pregnant woman and/or her unborn child (Leddy et al., 2008). Modifiable health indicators could be used to predict the health status or quality of life of a woman during and after pregnancy (Mariona, 2017). One such health indicator is prenatal obesity status, a known risk factor for many health outcomes, which was the primary predictor variable under investigation in this study. Mariona (2017) suggested that maternal obesity posed adverse health effects on pregnancy-related deaths.

In the obstetric practices, maternal obesity is a problematic health issue that could lead to negative health outcomes for both pregnant women and fetuses (Leddy et al., 2008). Maternal obesity during pregnancy is a risk factor for preeclampsia, severe gestational diabetes, and hypertensive heart conditions (Begum, Sachchithanantham, &

De Somsubhra, 2011). The obese status of a woman poses serious health risks to the unborn fetus, which could lead to a stillbirth delivery and/or congenital anomalies (Begum et al., 2011). Stillbirth and congenital abnormalities pose substantial economic and health care burdens at prepartum and postpartum stages (Begum et al., 2011).

African American, Black Caribbean, and Hispanic women are at higher risk of obesity when compared to the rest of the population (Sullivan, Brashear, Broyles, & Rung, 2014). Among the factors associated with obesity, poor diet lifestyle choices and lower or lack of perceptive knowledge on the health risks were reported (Sullivan et al., 2014). Poor diet lifestyle choices and lower perceptive knowledge of obese health risks were higher among woman with low health literacy (Lupattelli, Picinardi, Einarson & Nordeng, 2014). Behavior change measures on maternal obesity conditions is an important intervention needed to encourage and promote high health literacy among vulnerable women before pregnancy and at the early stages of pregnancy (Lupattelli et al., 2014).

Background

This study was inspired by prior studies on obesity and preterm births. When obesity is a prevalent health predictor variable for many health outcomes among women of reproductive age, it is a preventable and amendable health event (World Health Organization, 2019). Obesity is a contributor to developmental disabilities among offspring of obese mothers (Hinkle, Sharma, Kim, & Schieve, 2013). A comparison between children of normal weight mothers and those of obese mothers indicated an increased risk of learning and behavioral disabilities among children of the obese mothers, but not an increased risk for physical disabilities by the age of kindergarten (Hinkle et al., 2013). Hinkle et al. (2013) provided important baseline information on the risks of maternal obesity and its effects on their offspring.

Maternal prepregnancy obesity and cognitive scores of their offspring during the early primary school age were explored by Tanda, Salsberry, Reagan, and Fang (2013). Maternal prepregnancy obesity and child cognitive test scores were statistically correlated (Tanda et al., 2013). Social determinants of health or geolocation were also correlated to maternal prepregnancy obesity and child cognitive test scores (Tanda et al., 2013). Individuals living in a disadvantaged environment during postnatal stages were mostly affected by these risk factors (Tanda et al., 2013).

Logie et al. (2012) examined the association between preeclampsia and the effects of severely obese mothers during pregnancy. The peptide kisspeptin served as the biomarker for early detection and sensitivity of the disease (Logie et al., 2012). Logie et al. concluded that peptide kisspeptin is an effective indicator for preeclampsia and low birthweight. However, Logie et al. indicated that kisspeptin could not be considered for universal screening because of the lack of test sensitivity and specificity.

Lagerros, Cnattingius, Granath, Hanson, and Wikström (2012) employed a cohort of 323,083 women to demonstrate the link between gestational diabetes mellitus (GDM) and the role of the mother’s birthweight. Lagerros et al. concluded that gestational diabetes increased among women who were born at either high or low birthweight for gestational age. Based on the findings, Lagerros et al. emphasized the need to maintain a healthy weight. Many studies demonstrate that public health practitioners in various countries and disciplines understand the need for maintaining a healthy weight and encourage lifestyle change programs to promote healthy measures among individuals at risk.

In Australia, Morrison et al. (2012) assessed the nutritional benefits and Australian diet quality among pregnant women with GDM. Morrison et al. demonstrated that the participants' diet quality measure was very poor diet lifestyle based on the Australian recommended food score criteria. Among the participants, there was an increased risk of type 2 diabetes (Morrison et al., 2012). Morrison et al. suggested that diet quality and nutritional lifestyle contributed to the development of the type II diabetes and GDM. Morrison et al. further suggested that targeted interventions should be administered to women with GDM to promote a healthy postpartum diet adoption consistent with the chronic disease prevention guidelines.

The food-based guidelines in Norway were also of interest on weight retention concerns. Among Norwegian mothers, von Ruesten et al. (2014) investigated the association between the dietary lifestyle and six-month postpartum weight retention. It was observed that retention of excessive weight during pregnancy could lead to postpartum weight gain and may contribute to increased obesity prevalence (von Ruesten et al., 2014). The Nordic nutrition recommendations were positively associated with actionable implementations of adequate nutrient supply for mothers and the unborn child (von Ruesten et al., 2014). Healthy diet choice and lifestyle changes are key preventive measures for excessive maternal weight gain (von Ruesten et al., 2014).

Problem Statement

Low birthweight is a risk factor linked to many chronic diseases and disorders for both males and females (Lagerros et al., 2013). Female children who are born with a high or low birthweight are at an increased risk of gestational diabetes in their adult life during pregnancy (Lagerros et al., 2013). Obesity is one of the major risk factors of neonate low birthweight among reproductive women (Lagerros et al., 2013). Obesity is also a risk factor for many chronic conditions that pose health challenges globally. Approximately 35.8% of reproductive-age women within the United States are obese (Kominiarek, Gay, & Peacock, 2015). Maternal adiposity during pregnancy has been linked to a variety of health problems in newborns (Gaillard, Felix, Duijts, & Jaddoe, 2014). Other obesity-linked behavioral covariates including sedentary, lack of physical activities, and poor diet choice during pregnancy period could influence a woman's birth outcome (Mohd-Shukri et al., 2015). Using a prospective cohort research design with 148 severely obese women, Mohd-Shukri et al. (2015) demonstrated that the obese subjects had a poor nutritional lifestyle, which resulted in lack of essential nutrients (e.g., iron, B12, folate) necessary to nourish an unborn to a healthy state through a full pregnancy term. The incidence, prevalence, and risk of obesity and preterm birth/pregnancy complications among the racial groups are disproportionately distributed (Centers for Disease Control and Prevention [CDC], 2016; Sullivan et al., 2014). The Hispanic and African American populations are at a higher risk of developing pregnancy complications such as preeclampsia, GDM, caesarian sections, and stillbirths (CDC, 2016; Sullivan et al., 2014).

According to McDonald, Han, Mulla, Beyene, (2010), obesity correlatively predicts adverse pregnancy and birth outcomes. McDonald et al. also suggested, “Future research was needed to try to determine why overweight and obese women are at risk of preterm birth and to determine effective methods of weight loss in women of childbearing age before pregnancy,” (p.16). In a different study setting, de Jongh, Paul, Hoffman, and Locke (2014) addressed the suggestions proposed by McDonald et al. (2010) but came up with another proposal emphasizing the need for further investigation to understand the differential association of moderate, severe, and very severe obesity among childbearing-age women. Although the initial population was large, the analysis along a race/ethnicity and obesity interaction caused the subpopulation numbers to be smaller and created risk for type II error (de Jongh et al., 2014). Therefore, the observed findings applied only to the participants in the study and were not generalizable to all geographic populations (de Jongh et al., 2014). Based on the gap in the literature identified by de Jongh et al. (2014), I examined the influence of obese category status (moderate, severe, and very severe) on the risk of preterm birth and neonate birthweight among women of childbearing age. There was also a need to identify factors that could affect weight loss before pregnancy among women of childbearing age.

Purpose of the Study

The purpose of this study was to investigate the association between three categories of obese (moderate, severe, and very severe) and low neonate birthweight and preterm birth among women of reproductive age at any socioeconomic status. This study included a cross-sectional design because the aim was to estimate the prevalence of the neonate birthweight and preterm birth among the women at risk. The application of a quantitative method aligned with the research questions and study objectives. Obesity is a risk factor for many diseases, and understanding its effects and association with neonate birthweight and preterm births among the vulnerable target population is necessary for effective health promotion measures and for reducing the attributable effects of obesity to the health outcomes under investigation (McDonald et al., 2010).

The obesity estimation was based on the individual's body mass index (BMI) score (National Institute of Diabetes and Digestive and Kidney Diseases, 2013). Moderate obesity is a BMI of 30 to less than 35 (CDC, 2016). Severe obesity is a BMI of 35 to less than 40 (CDC, 2016). Very severe obese is a BMI greater than 40. Preterm birth is delivery before 37 weeks gestation (CDC, 2016). Low birthweight is child born at body weight less than or equal to 5.5 lbs. (CDC, 2016).

Factors affecting weight loss among women of childbearing age were also explored in the current study. Based on the operational variables (obesity status, preterm birth, and neonate birthweight), I used a quantitative approach to address the identified gap. The targeted population for this study included women of childbearing ages 18-39 within the United States. The outcomes or dependent variables under investigation were preterm birth and neonate birthweight. The predictor or independent variables of interest were obesity levels categorized as moderate, severe, or very severe based on BMI values) and factors predicting weight loss among women of childbearing age. Women with a normal body weight measurement or moderate obese status were used as the control group for assessing the obese category effect on the preterm birth and neonate birthweight.

All confounders are covariates (Creswell, 2009; Gordis, 2009; Szklo & Nieto, 2014). However, covariates are not necessarily confounders (Creswell, 2009; Gordis, 2009; Szklo & Nieto, 2014). Confounders are associated with both the predictor and the outcome variables (Creswell, 2009; Gordis, 2009; Szklo & Nieto, 2014). On the other hand, covariates interact with only the outcome variables (Aschengrau & Seage, 2014; Gordis, 2009; Krieger, 2011); Moeller, 2011). Some of the relevant confounders identified in this study were age, education, income, marital status, race, and ethnicity because all were identified to be linked to both the independent variable and at least one outcome variable. This study's findings may inform the design of more effective health promotion and preventative measures on birth-related risks factors of obesity among women of childbearing age. Findings may also include recommendations regarding future studies and prenatal education implementation among childbearing women at any socioeconomic status. Maternal care programs supporting a healthy pregnancy and prenatal care services could benefit from the findings of the study. Also, the findings may be of interest to public health agencies (e.g., local or state health departments, Health Resources and Services Administration, CDC, and National Institute of Health) interested in obesity outcomes and comorbidities to promote wellness and women's empowerment. The findings provided in the study may also contribute to the advancement of community-based health promotion measures relating to obesity, preterm birth, and neonate birthweight problems.

Research Questions and Hypotheses

The following research questions (RQs) were used to guide this study:

RQ1: Is obesity status (moderate, severe, and very severe) among women ages 18-39 years associated with a change in the prevalence of preterm birth when compared to women with a normal body weight?

H_{o1}: Obesity (moderate, severe, and very severe) among women ages 18-39 years is not associated with a change in prevalence of preterm birth when compared to women with a normal body weight are not different.

H_{a1}: Obesity (moderate, severe, and very severe) among women ages 18-39 years is associated with a change in prevalence of preterm birth when compared to women with a normal body weight.

RQ2: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese?

H_{o2}: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

H_{a2}: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

RQ3: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese?

H_{03}: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from who are severely obese.

H_{a3}: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese.

Theoretical Framework

The social-ecological theory developed by Bronfenbrenner was used to explain the interactions between women of childbearing ages (18-39). I examined the relationship between obese status (moderate, severe, and very severe) and preterm birth and low birthweight. This model contained operational constructs that were used to explore the effects of obesity on preterm birth and neonate birthweight by evaluating some of the internal factors such age, income, education, race, and ethnicity. The external factors associated with the phenomenon, such as the marital status of women, was explored as well. The interactive perspectives of a community, individual, or organization within the microsystem, mesosystem, exosystem, macrosystem, and chronosystem were used to explore the specified factors (see Bronfenbrenner, 1994).

The microsystem includes the immediate factors that exert influence on an outcome (Bronfenbrenner, 1994). The exosystem operates outside of the microsystem but is influenced by the elements in the microsystem (Bronfenbrenner, 1994). The exosystem includes external elements that influence an outcome or event (Bronfenbrenner, 1994). Macrosystem is a broader external composite of environmental factors that promote an event or outcome (Bronfenbrenner, 1994). The chronosystem constitutes the overall or cumulative exposure environment that influences an event or outcome (Bronfenbrenner, 1994).

Bronfenbrenner (1994) highlighted elemental constructs (e.g., social and economic factors, network system) that interact with different environmental factors (e.g., communities) that could influence various behaviors, health outcomes, and events. In the current study, the five environmental systems specified in the socioecological theory (SET) were used to explain the observed phenomenon. I explored the direct environmental state (income and education status of maternally obese women and its relationship to the lifestyle (microsystem environment) that predisposes the women to common risk factors (see Paquette & Ryan, 2001). The mesosystem (maternal age, maternal BMI, and race) in this study interacted indirectly with the other systems and produced an influence on the observed outcome (see Paquette & Ryan, 2001). The exosystemic (marital status) environment was also explored as a potential link between obesity and preterm birth outcomes. The effects and influence of some of the confounders such as race, ethnicity, income, and education, which are part of the macrosystem in the study, were also explored (see Paquette & Ryan, 2001). Through the sociohistorical conditions or life course perspectives of the chronosystem, which included income and maternal education, I was also able to determine whether a shift in the maternal obese status had any influence on the health outcome (i.e., pre-health issue identifiers).

Nature of the Study

A quantitative method was employed to address the research questions and hypotheses. The operational constructs contained objective elements, including obesity measurement through BMI estimation and neonate birthweight estimation. The primary outcome or dependent variable for the first research question was preterm birth, and the primary outcome for the second research question was neonate birthweight. The independent or predictor variable of interest was the maternal obese status (moderate, severe, very severe).

For this study, I used a cross-sectional design approach, which is commonly employed in a correlational study that involves risk and prevalence estimations (Creswell, 2009). The data collection approach for this study was survey-driven. However, the survey data were obtained from a secondary data set from the CDC and state health departments. The data were de-identified and accessible upon permission from the CDC Pregnancy Risk Assessment Monitoring System (PRAMS) team.

The target population included women of childbearing age (18-39) living in the United States who were considered obese based on a BMI value greater than 30. These women were considered at risk and exposed. Women with a normal BMI within the range of 18.5 to 24.9 were not at risk and were the control group. The total sample size for this study was 141,859 participants. The participants' inclusion criteria were women who had a baby or had a preterm birth. The focus of the third research question was a descriptive analysis of possible confounders or covariates that influence the specified health outcomes. Such descriptive analysis could be used to expand exploration of the effects of weight loss among the most vulnerable subjects and perhaps be employed in meaningful intervention approaches to these public health problems.

Definitions

Terms used in the study that have multiple meanings were defined as follows:

Body mass index (BMI): A measure of body weight as it relates to a person's height. BMI is used to determine whether a person is underweight, normal weight, overweight, or obese (National Institute of Diabetes and Digestive and Kidney Diseases, 2013).

Chronosystem: The dimension of time as it relates to a person's environment; for example, all of the experiences a person would have over his or her lifetime, including environmental events, major life transitions, and historical events (Bronfenbrenner, 1994).

Exosystem: The larger social systems that influence a person indirectly; for example, health care, neighborhood, mass media (Bronfenbrenner, 1994).

Extrinsic: Externally motivated activities or factors generally unrelated to a person's needs but aimed at obtaining outcomes that are separable from the activities themselves (Górnik-Durose, Jach, & Langer, 2017).

Gestational diabetes: A health condition during pregnancy in which a woman's body cells metabolize insulin less effectively (insulin resistance); a condition that may increase the body's need for (insulin resistance); a condition that may increase the body's need for insulin. This condition may develop in pregnant women who are diabetic before pregnancy (CDC, 2016).

High birthweight: A birthweight ≥ 4,000 grams (8lb 14 oz.) and ≥ 5000 grams (11lb 1 oz.) (Hill, 2019).

HX previous: Medical history previous (CDC, 2018).

Incidence: The number of individuals who develop a specific disease or encounter a health-related event during a specific period (Harvard University, 2017).

Intrinsic: Internally motivated activities or factors that serve as a source of positive emotions and stimulate personal development (Małgorzata Górnik-Durose et al., 2018).

Low birthweight: A birthweight less than 2,500 grams (5 1/2 lbs) (CDC, 2016).

Macrosystem: Describes the type of culture in which a person lives; for example, cultural would be in the context of a person's socioeconomic status, poverty level, and ethnicity (Bronfenbrenner, 1994).

Mesosystem: The connection between the structures of a person's microsystem; for example, something that affects the child directly (i.e. family, school) (Bronfenbrenner, 1994).

Microsystem: The relationships and interactions a person has with his or her surroundings; for example, the structures with which the child has direct contact (Bronfenbrenner, 1994).

Moderate obese: Obese Class Level 1 includes individuals with a BMI of 30 to <35 (CDC, 2016).

Normal Birthweight: A birthweight between 2,500 grams (5lb 9 oz.) and 3,999 grams (8lb 13 oz.) (Hill, 2019).

Normal BMI: A person's BMI within the range of 18.5 to 24.9 (CDC, 2017a).

Obesity: Excess body fat defined by BMI. An adult with a BMI ≥ 30 is categorized an obese (National Institute of Diabetes and Digestive and Kidney Diseases, 2013).

Overweight: A BMI range between 25.0 and *<30 (*National Institute of Diabetes and Digestive and Kidney Diseases, 2013).

Preterm birth: A baby born before 37 weeks of gestation (CDC, 2017b).

Prevalence: The percentage of individuals within a population who have a disease or health-related condition during a specific period (Harvard University, 2017).

Severe obese: Obesity Class Level 2 includes individuals with a BMI range of 35 to < 40 (CDC, 2016).

Underweight: A BMI < 18.5 (CDC, 2017a).

Unit of analysis: Group of people, categories, elements, or factors under investigation in a study (Creswell, 2009). The control group and the experimental group, or the nonexposed and exposed group, respectively, were the units of analysis in this study.

Very severe obese: Obesity Class Level 3 include individuals with BMI range ≥ 40 (CDC, 2016).

Assumptions

Assumptions inform the initial steps of an evidence-based inquiry (Gordis, 2009; Szklo & Nieto, 2014). When assumptions are made, questions are posed, and in a research setting, unanswered questions drive the researcher to investigate the reliability and validity of such prepositions (Gordis, 2009; Szklo & Nieto, 2014). In some cases, advancing assumptive positions as the basis of a new research inquiry without any supportive evidence-based findings could produce or introduce biases in a study (Gordis, 2009; Szklo & Nieto, 2014).

Several assumptions were present in this study and were mitigated to the extent possible. For instance, the secondary data were assumed to be accurate. However, self-report measurement via a survey may not be accurate. Measurement error in self-reported variables is likely to occur (Brenner& DeLamater, 2016). Without objective measurements to verify self-reported information, there is not much a researcher can do about the reliability and validity of the self-reported data. The results produced from such data could be distorted.

Another assumption was that preexisting health conditions such as diabetes, genetic disorder, and heart disease can influence the inclination to obese status and consequently lead to preterm birth and neonate birthweight outcomes among vulnerable women. The settings of the study made it easier to assume that the participants did not already have preexisting conditions other than diabetes or high BMI measurements that lead to the obese condition. In other words, the obese status of the participants could have been a secondary product from a preexisting health condition that influences the subsequent health outcomes. The use of secondary data for this study made it harder to mitigate or exclude individuals with a preexisting condition if such conditions were not measured or captured in the data set being used. This is important because the original purpose of the secondary data may not fully align with the intent of the current study even when all of the variables within the secondary data represented the variable of interest specified in this study.

Social determinants of health play a key role in a person’s physical, mental, and physiological well-being (Gordis, 2009; Szklo & Nieto, 2014); Wilkinson & Pickett, 2010). The physical environment or the social conditions in which people live shape their thought, lifestyles, and cultural values, and most importantly determine their quality of life (Gordis, 2009; Szklo & Nieto, 2014; Wilkinson & Pickett, 2010). Social or environmental interactions are important in maintaining lifestyle values. It would be erroneous to assume that all of the participants shared similar social and physical experiences (Wilkinson & Pickett; 2010). In other words, it is not realistic that all of the selected participants in this study had similar life course perspectives. For instance, some participants may or may not have engaged in drug use, alcohol use, and smoking while pregnant. If these variables were not measured in the secondary data set or captured as confounders or covariates, it is possible that the effects attributed to the obesity categories on preterm birth and neonate birthweight were not accurately represented in this study. In such cases, the unaccounted effects are discussed as limitations and delimitations of the study.

Scope and Delimitations

Advancing meaningful and sustainable health promotion measures in public health or epidemiological settings requires informed health programs consistent with evidence-based evaluation processes to foster an engaged-community environment, health awareness advocacy, and health literacy education on specific risk factors associated with health outcomes in question (Trinh-Shevrin, Islam, Nadkarni, Park, & Kwon, 2015). These are critical elements in the improvement of population quality of life efforts (Kickbusch, 2001). These factorial and crucial elements are interlinked with the unit of analysis and other aspects of this study. The unit of analysis in this study included women and excluded men. Among women, individuals under the age of 18 years were excluded from the study. Women of reproductive age (18-39 years) were included in the study. Women categorized as underweight (BMI < 18.5) and overweight (BMI 25.0 to <30) were excluded in the study. The participants had to be categorized as either normal weight or moderate, severe, or very severe maternally obese based on the BMI levels specified in the Definitions section of this chapter.

The BMI levels were the core boundaries of the study as it relates to the unit of analysis and within the human obesity range defined by the CDC. I used Bronfenbrenner’s SET to explain the interactive phenomenon between the various maternal obese categories (moderate, severe, or very severe) and preterm birth and neonate birthweight. In this study, the exploration could be conceptualized using only the core SET constructs: microsystem, exosystem, mesosystem, macrosystem, and chronosystem (see Bronfenbrenner, 1979). In other words, all of the observed phenomena were required fit within the SET. Otherwise, the interpretation of the phenomenon would be compromised. Generalizability of the findings was unlikely because this was not a multisite study. The findings were limited to the selected target population.

Limitations

The research design employed in this study had inherent weaknesses. A cross-sectional research design in the absence of an experimental study can only be used to draw a correlational inference and never causal effects (Creswell, 2009). The application of a quantitative method eliminates subjective experiences shared among the participants (Creswell, 2009). Also, the methodology, which involved the application of a secondary data set, could have affected the reliability and validity of the data. Data integrity issues could have led to a type I (false positive) or type II (false negative) error.

When secondary data is used in a study, self-reported data may not be independently verified because the de-identified information reported in the data set is the only information available in most cases. Another limitation was the measure used to collect the data. The measures used in the previous study for data collection may have affected the thoroughness of the analysis and the results in the current study. Also, in many cases, the purpose for which the secondary data researchers collected the data may not accurately represent the objectives and intentions of the current study. All of these factors or barriers may have affected the scope of the analysis, sample size estimation, and identification of meaningful trends and relationships.

Confounder variables could have also affected the results. The participants could have had an existing health risk that covaried with the predictor variable(s) and intended health condition(s) under investigation, or could have developed a health risk during pregnancy unrelated to obesity but that affected the health outcomes. In a study containing secondary data, the primary confounders (if not captured/measured by the original data collectors) can distort statistical analysis. Secondary data application can also be manipulated to fit the purpose of the study, which could produce researcher bias effects (Šimundić, 2013).

Significance

A birth outcome is a common predictor of the overall national health quality of a country. The high prevalence of obesity among childbearing-age women in the United States is 27.5%, which makes this health outcome a societal and public health issue (Kominiarek et al., 2015). Evidence that obesity is linked to a variety of health outcomes supported the need to identify its relationship to preterm birth among the specified obese categories (moderate, severe, and very severe). Findings may be used in the implementation of early preventative measures of child obesity in the United States among vulnerable women. The findings from this investigation may promote intervention approaches that may decrease other covariate health outcomes associated with child obesity such as type II and type I diabetes. Other behavioral abnormalities associated with child obesity such as inactivity, nutritional problems, and dietary problems could be further explored among the vulnerable population.

In addition, this study's findings may be used to promote positive social-behavioral change among the compromised pregnant women, which could motivate vulnerable women to lose weight. Findings may encourage maternal care practitioners to strengthen or introduce prenatal care practices that focus on weight loss. A weight loss program could include personalized assessment of nutritional quality, exercise, and lifestyle planning. Such weight loss programs could be implemented in a nonjudgmental environment and covered by health insurance plans. Medical checkups for weight-loss programs may include customization and targeted plans based on individuals' family history of health conditions. The program may include classes through which participants could learn how to maintain a healthy weight through their life course.

Through improved understanding of the difference in the prevalence and risk of preterm birth and neonate birthweight incidence among moderate, severe, and very severe obese women, clinicians and public health practitioners could advance inclusive and integrated health and wellness programs to address this issue. One approach is to include in the screening overview questions about obesity and lifestyle changes during the primary care physician visits. Women at risk could be referred to health coaching services or lifestyle programs such as the National Diabetes Prevention Program or Expanded Food and Nutrition Education Program. Also, if the factors that affect weight loss in women of childbearing age before pregnancy are identified in this study, public health agencies and health professionals could explore them in future studies and use the information obtained from this research to advance health promotion awareness to promote evidence-based positive social change for related health outcomes and concerns.

Summary

In Chapter 1, I presented the study's background, problem statement, purpose, research questions, theoretical framework, nature of the study, definitions, assumptions, scope and delimitations, limitations, and significance. I described the effects of moderate, severe, and very severe obese conditions among women of childbearing age on preterm births and neonate birthweight. The literature review is provided in Chapter 2. I address the various levels of obesity, its effects on preterm birth and neonate birthweight, and the direct and indirect effects on children because of prenatal maternal obesity.

Chapter 2: Literature Review

Pregnancy is a sensitive and delicate time for women who are in their gestation period. The gestation period, if not well taken care of, can adversely affect the mother's life or her unborn child during or after birth. A woman's health status before pregnancy is an important indicator that could lead to either a healthy and safe pregnancy or series of complications and adverse health risks. Obesity is one health status that is a risk factor for adverse pregnancy outcomes; maternal obesity is a major health issue in obstetric practices that could lead to negative outcomes. Maternal obesity status during pregnancy can also lead to conditions such as preeclampsia, gestational diabetes, and hypertension (Begum et al., 2011).

The mother's obese status exposes the unborn fetus to the risk of stillbirth and congenital anomalies (Begum et al., 2011). Stillbirth and congenital abnormalities create additional economic and health care burdens to the parents during the postpartum terms. The purpose of this study was to assess the association between three maternal obese statuses (moderate, severe, and very severe) and preterm birth and neonate birthweight. I also explored the factors that influence weight loss in women of childbearing age. Women in the African American, Black Caribbean, and Hispanic communities are at higher risk of obesity when compared to the rest of the population (Sullivan Brashear, Broyles, & Runger, 2014). Among the factors associated with obesity, poor diet was reported as a factor together with the perception of health risks, which were lower among woman with lower health literacy (Sullivan et al., 2014).

To promote health literacy about maternal obesity interventions among vulnerable women (prepregnancy and women at early stages of pregnancy), adherence to a behavioral change approach is necessary (Lupattelli et al., 2014). In Chapter 2, I explain various literature search strategies used to conduct this literature review, and the databases that were accessed for the searches. Also, I describe the theory used for this study. How the theory has been used in previous studies, along with the rationale for the use of the theory in this particular research inquiry is explained as well. The conceptual framework is also reviewed by identifying and explaining the key operational constructs and definitions of the theoretical framework. The literature review related to the key variables and concepts was synthesized to describe relevant literature related to the theoretical constructs of interest, research design, research method, and methodology used in the literature and how the totality of the literature content related to my study. I conclude the chapter with a summary.

Literature Search Strategy

All documents related to the literature review were accessed through the Walden University library. I had direct and free access to the following research databases: CINAHL, MEDLINE, PubMed, Elsevier, and Science Direct. The articles retrieved from these databases were published in at least one of the following journals:

- *American Family Physician*,
- *American Journal of Obstetrics & Gynecology*,
- *Atherosclerosis*,
- *European Journal of Epidemiology*,

- *Journal of the American Academy of Nurse Practitioners*,
- *Journal of Health Communications*,
- *Maternal and Child Health Journal*,
- *Midwifery Journal*,
- *Obesity Journal*,
- *Nutrition Research Journal*,
- *Pediatric Respiratory Reviews*,
- *Patient Education and Counseling*,
- *SSM-Population on Health*, and
- *Women's Health Issue Journal*.

Several key terms were used to search for relevant articles related to this research topic: *maternal obesity, obese Hispanic pregnancy, Hispanic pregnancy, pregnancy obese, obese pregnancy, Black obese pregnant, pregnant African American, pregnant African American pregnancy obese, health literacy obese, health literacy pregnancy*, and *obese birth*. For example, a search with the key words "maternal obesity" in the *American Journal of Obstetrics and Gynecology* within the last five years produced 976 articles. A search with the key words "preterm birth" in the same journal within the last five years produced 2,995 articles. A search with the key word "birthweight" in the *American Journal of Obstetrics and Gynecology* within the last five years produced 1,312 articles. In contrast, a literature search with the key words "maternal obesity" AND "preterm birth" AND "birth weight" in the *American Journal of Obstetrics and Gynecology* within the last five years produced only 187 articles. All literature searches were limited to articles written in the English language. The five-year range for the literature search was between 2012 and 2017. Keeping the range within five years to the present date allowed for an up-to-date literature review on the topic of maternal obesity or obesity publication, and provided a better understanding of key topics that have been studied and their significance to this study. The review was helpful in comparing current and relevant findings relating to the research topic for this study.

Theoretical Foundation

Bronfenbrenner (1994) originally developed the SET as a model for explaining the effects of intrinsic and extrinsic factors on child development in the 1970s (Bronfenbrenner, 1994; Oswalt, 2017). The five constructs of the SET are the microsystem, mesosystem, exosystem, macrosystem, and chronosystem (Bronfenbrenner, 1994; Oswalt, 2017). These systems can be used to explain the interactive relationships of an event and its intrinsic/extrinsic influencing factors (Bronfenbrenner, 1994; Oswalt, 2017).

This theory has been used in many studies to explain the biological, behavioral, social, and organizational phenomena (Baraka, Rusibamayila, Kalolella, & Baynes, 2015). For example, Baraka et al. (2015) used the SET to explain the phenomenon of the unmet needs of contraception in Tanzania and how the capabilities of service providers are determined by the social, structural, and organizational factors. In the study, Baraka et al. showed that individuals, society, and health systems interact with and influence service providers' ability, which makes it challenging for the providers to offer quality family planning services. Baraka et al. also used the SET to explain the unsatisfactory involvement of men in the maternal and child health care processes, which they suggested was because of the systemic exclusion of men in the process even when they were the primary providers in the family. Baraka et al. concluded that organizational constraints prevented effective implementation of high-quality services.

The rationale for applying the SET in this study was that by exploring the five operational constructs of the model, the prevalence rate of preterm birth could be explored. Similarly, the association of obese status and low neonate birthweight among women of reproductive age could be quantifiably explained. In this study, the difference in prevalence between preterm births among vulnerable women in the three selected obese groups (moderate, severe, and very severe) was evaluated against women with normal body weight. Understanding the association between women of severely obese status and neonate birthweight, and the key factors that could affect weight loss in women of childbearing age before pregnancy is important to public health efforts and health promotion measures (Gunderson, 2010). Five operational constructs of the SET systems were used to explore the environmental factors that could affect pregnant women. From the literature review findings and assessments, it is possible and important to explore further the factorial risks of maternal obesity (Fink, 2010). In addition, with the exosystem level, the direct links between maternal obesity and preterm birth and neonate birthweight could be explored.

Conceptual Framework

This theory was selected for this study because it is a well-fitted model that could be used to explain the interactions between the maternal obese categories (moderate obese, severe obese, and very severe obese) and preterm birth and neonate birthweight problems. The SET consists of five elemental constructs known as the microsystem, exosystem, mesosystem, macrosystem, and chronosystem**.** The microsystem entails a person's inclusive environment with direct social interactions or contacts with family, friends, neighbors, and close relatives, (Sincero, 2017). The exosystem is an environment in which an individual is not directly involved and it is external to their experience; however, they are still affected (Sincero, 2017). The mesosystem involves the effects of the established relationship a person has within their microsystems and associated determinants (Sincero, 2017). An example of a mesosystem relationship would be a child who had a bad relationship with his or her parents and it resulted in a barrier in developing positive attitude toward another person of authority (Sincero, 2017). The macrosystem is the fourth system of SET. It is used to explore the culture of an individual, which may include the socioeconomic status, ethnicity, and race, etc. of an individual and the social environment. The chronosystem relates to the transitions and shifts within a person's life (life course perspective) such as the effects of divorce on a child (Sincero, 2017). Using the SET, the following three research questions were addressed:

RQ1: Is obesity status (moderate, severe, and very severe) among women ages 18-39 years associated with a change in the prevalence of preterm birth when compared to women with a normal body weight?

H$_{o1}$: Obesity (moderate, severe, and very severe) among women ages 18-39 years is not associated with a change in prevalence of preterm birth when compared to women with a normal body weight are not different.

H$_{a1}$: Obesity (moderate, severe, and very severe) among women ages 18-39 years is associated with a change in prevalence of preterm birth when compared to women with a normal body weight.

RQ2: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese?

H$_{o2}$: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

H$_{a2}$: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

RQ3: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese?

H$_{03}$: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from who are severely obese.

H_{a3}: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese.

Table 1

SET summary and relation to conceptual framework

The SET elements, related variables and confounding effects		
SET elements	Related variables	Relation of Variables
Microsystem	Income / Education	Confounder
Mesosystem	Maternal age	Confounder
	Race	Confounder
Exosystem	Marital status	Confounder
		Confounder
Macrosystem	Income/ Education/	Confounder
	Race/ Ethnicity	Confounder
Chronosystem	Income	Confounder
	Maternal education	Confounder

The five theoretical constructs implicated in the SET are useful elements in addressing the phenomenon associated with the research questions by identifying the interactive components within different environmental factors (extrinsic factors) that could influence various behaviors, health outcomes, and events (Bronfenbrenner 1994). By applying the SET in this study, the operationalized microsystem (intrinsic factors) was used to evaluate the interactive relationship of maternal obese and preterm birth and neonate birthweight problems. In addition, the environmental systems were evaluated to understand the direct effects of maternal obesity and its relationship in the microsystem levels among these women. Most importantly, by using this theory, the exosystemic environmental construct, exploration of potential links between maternal obesity and preterm birth/neonate birthweight outcomes was identified along with the possible effects of the covariates/confounders.

The exosystemic environment was explored as a potential link between obesity and preterm birth outcomes. The effects of the confounders (age, income, marital status, race, and ethnicity) were identified within each of the mentioned elements (mesosystem, exosystem, macrosystem, and chronosystem) were also explored in this study. Through the chronosystem level, the evaluation on whether maternal education or income influenced preterm birth or child birthweight was also explained. Therefore, the SET was a crucial element in achieving the purpose of this study.

Literature Review Related to Key Variables

The need for further studies on maternal obesity and its consequential effects on preterm birth and neonate birthweight was based on the gap in the literature proposed by de Jongh et al. (2014). The literature reviewed below contains relevant information on research designs, methods, methodology/other approaches, and findings that steered the meaningfulness and evidence-based foundation for this study.

Risk of Maternal Obesity

Hinkle, Sharma, Kim, and Schieve (2013) identified obesity as a prevalent health outcome among women of reproductive age. A comparison of children of normal weight mothers and children of mothers classified as obese was conducted. The study identified that children of obese mothers had an increased risk of learning and behavioral disabilities, but not an increased risk for physical disabilities by the age of kindergarten. Overall, Hinkle et al. (2013) concluded that obesity was a contributor to developmental disabilities among offspring of obese mothers (Hinkle et al., 2013).

Authors von Ruesten et al., (2014) explored the food-based guidelines among Norwegian mothers and its association to six-month postpartum weight retention. The investigators recognized that excessive weight during pregnancy could lead to postpartum weight gain and may contribute to the increase in the obesity incidence and prevalence, and concluded that the Nordic nutrition recommendations are positively associated with actionable recommendations of adequate nutrient supply for mothers and the unborn child (Von Ruesten et al., 2014). They also suggested that it promoted preventive measures on excessive maternal weight gain (von Ruesten et al., 2014).

Kurspahić-Mujčić1 & Zećo, (2017) conducted a cross-sectional study among 300 women to determine socioeconomic and demographic factors associated with abdominal obesity of women of childbearing age. The study results also indicated that women between the ages of 20-29, who resided in urban areas and had a university-level education and a higher-than-average financial status, were significantly associated with abdominal obesity (Kurspahić-Mujčić1 & Zećo, 2017). Kurspahić-Mujčić1 & Zećo, (2017) concluded that more focus was needed on university education of women of childbearing age to reduce abdominal obesity.

Chen (2009) explored factors associated with poor dietary behaviors among Chinese women who have immigrated to the United States and their children. Chen

(2009) suggested that an intervention to reduce obesity and promote health behaviors was warranted among immigrant ethnic groups of various levels of income and acculturation.

Sobol and Hanson (2011) investigated marital status and history, and its association with health status, among 3,011 adults during a retrospective analysis. These researchers found that never-married women were heavier and more likely to be obese than married women (Sobol & Hanson, 2011). Body weight and obesity were also found to be associated with current marital status but not marital history (Sobol & Hanson, 2011).

Izoton de Sadovsky, Mascarello, Miranda, and Silveira (2018) conducted a systematic review to explore whether income, education, or ethnicity were associated with low birthweight. The literature review covered materials published from January 1982 through May 2016, which produced 157 relevant studies (Izoton de Sadovsky et al., 2018). From the review, an association was identified between ethnicity and three infant outcomes: infant prematurity, infant small for gestational age, and fetal growth retardation (Sadovsky et al., 2018). Izoton de Sadovsky et al., (2018) also emphasized that prematurity was predominantly found among children of black mothers (Sadovsky et al., 2018).

Zaine, Low, and Othman (2015) conducted a prospective study to explore maternal marital status and its influence on birth outcomes among Malaysian women. Zaine et al., (2015) identified marital status to be significantly associated with preterm birth. Women who were not married were identified to be more likely to have complications than married women (Zaine, Low, & Othman, 2015).

In another study, Wallace, Mendola, Chen, Hwang and Grantz (2016) investigated income and its influence on preterm birth. The study was conducted in 11 states and the District of Columbia (Wallace, et al., 2016). In the study, changes in the equality of singleton deliveries was also investigated (Wallace et al., 2016). In the study, Wallace et al. (2016) concluded that income inequality was significantly associated with preterm birth.

Biological Effects of Obesity

Within the current body of literature reviewed were sufficient evidence-based findings in which researchers suggested the plausibility of adverse health effects linking biological factors to maternal obesity. Logie et al. (2012) examined some of the biological factors. The authors evaluated preeclampsia related to severely obese mothers during pregnancy (BMI >40). In this assessment, peptide kisspeptin served as the biomarker at 16-, 28-, and 36-week gestation periods for early detection and sensitivity of the disease (Logie et al., 2012). The conclusions drawn from the study indicated that the peptide kisspeptin was an effective indicator for preeclampsia and the assessment of low birthweight but could not be considered for universal screening because of low or lack of standardized sensitivity and specificity tests (Logie et al., 2012).

Social Determining Factors of Obesity

Sullivan, Brashear, Broyles, and Rung (2014) explored the associations between perceived neighborhood environments and obesity among the U.S. representative sample of Afro-Caribbean, African American, and Non-Hispanic white adults. The researchers used data from the National Survey of American Life between 2001-2003, which included neighborhood characteristics and self-reported height and weight indicators (Sullivan, et al., 2014). The study outcome indicated that obesity for adults that participated in clubs, help groups, or associations was significantly lower than those who do not participate in the listed social functions/groups (Sullivan et al., 2014). Race and ethnicity was also shown to affect the association between activity involvement and obesity (Sullivan et al., 2014). The authors concluded that providing places for activities (i.e. parks, playgrounds, open space) may contribute to more activity and prevention of obesity, especially among ethnically diverse neighborhoods within the United States; however, more research is needed (Sullivan et al., 2014).

Webb, Khubchandani, Hannah, Doldren, and Stanford (2015) recognized that a lack of physical activity is considered to be a leading contributor of obesity in the United States. These researchers conducted a cross-sectional research design to explore the perceived and actual physical activity behaviors among African American women (Webb et al., 2015). A questionnaire was employed with face validity to measure the readiness to change exercise habits, plans to change, and acting to change among 292 African American women that met the study's inclusion criteria (Webb et al., 2015). The study indicated that out of 292 women, more than half had a bachelor's degree and approximately 45.6% were not married with an average age of 36.4 (Webb et al., 2015). Approximately 83% of the participants reported having ≤3 healthy eating habits, yet 85.9% reported a family history of 1-4 chronic diseases (Webb et al., 2015). This study also indicated that 62% of the women failed to participate in aerobic exercises for three or more days per week to include strength and stretching exercises (Webb et al., 2015).

Webb et al (2015) concluded that a large number of African American women failed to regularly exercise and engage in physical activity, and this is strongly associated with stages of change for exercise. Those who were physically active compared to those who were not active had improved quality of life (Webb et al., 2015). Webb et al (2015) also concluded that a lack of physical activities was a strong predictor of obesity, which supported the relevant relationship between obesity and physical activity explored in this study. Therefore, exercise (lack of exercise among mothers) could be a possible confounder to preterm birth and neonate birthweight.

Sealy-Jefferson, Slaughter-Acey, Caldwell, Kwarteng, and Misra (2016) explored the neighborhoods of disadvantage and preterm delivery (PTD) in Urban African Americans and the moderating role of religious coping. In this retrospective cohort design, 1,411 women were included in the study (Sealy-Jefferson et al., 2016). Religiosity was used as an effect modifier to test whether various measures of religious coping altered the association between neighborhood disadvantage and PTD (Sealy-Jefferson et al., 2016). Sealy-Jefferson et al. (2016) identified evidence suggesting that individuals who utilized religiosity as an intervention approach (asking others to pray for them frequently) showed several positive neighborhood characteristics that were associated with increased PTD rates. Sealy-Jefferson et al.(2016) concluded that the reason for such findings is unknown because religious-social support is associated with positive outcomes and suggested that neighborhood quality may not impact PTD rates equally among all women and may be moderated by religiosity. Further investigation is needed regarding ways religious coping may aide in social support for women across their life-course perspectives, and how it may help to buffer exposures and social determinants of adverse birth outcomes.

Maternal Obesity and Health Outcomes

There are many relevant published scientific studies on the effects of maternal obesity and health outcomes. The following body of literature was reviewed to outline the possible health outcomes associated with obesity:

Lamminpää, Vehviläinen-Julkunen, Gissler, Selander, and Heinonen (2016) compared pregnancy outcomes of overweight and obese women who are 35 years or older to pregnant women aged 35 years or younger who were overweight and obese. This is a registry-based study conducted in Finland with data of women from 2004-2008 (Lamminpää, et al., 2016). These researchers showed that maternal overweight and obesity, along with advanced maternal age, had a significant increase in the risks of preterm delivery, preeclampsia, fetal death, and large for gestational age and caesarian compared to women of average weight and who are 35 years or younger (Lamminpää et al., 2016). However, women who are 35 years or younger and were overweight or obese experienced a significant increase in risks of preterm delivery and fetal death (Lamminpää et al., 2016). Lamminpää et al. (2016) concluded that women who are 35 years or older and who were obese or overweight were in a high-risk state for stillbirth and preterm delivery (Lamminpää et al., 2016).

Herring et al. (2012) conducted a study to assess the influence of excessive weight gain in pregnancy among urban low-income women. In the prospective cohort study design, the investigators employed 94 prenatal care participants to assess the associations of modifiable mid-pregnancy behaviors and non-modifiable factors with excessive gestational weight gain (Herring et al., 2012). Herring et al. (2012) concluded that high early pregnancy, null parity, and discordant clinician advice were directly associated with excessive gestational weight gain among the urban low-income women. A trend was also identified with decreased risk for viewing fewer hours of television and regular activity engagement, and among the targeted population, gestational weight gain could be optimized to aid long-term maternal health promotion measures (Herring et al., 2012).

Faucher and Barger (2015) conducted a systematic review of obese women undergoing weight gain and newborn outcomes. After exploring peer-reviewed journal articles using 3 electronic databases reference lists and table of content notifications, data was synthesized in order to identify the changes in risk by prevalence (Faucher and Barger 2015). Faucher and Barger (2015) research suggested that obese women were at low risk for small for gestational age and high risk for large for gestational age which varied according to the obesity class and gestational weight gain. Faucher and Barger (2015) also indicated that most obese women gained more than the recommended weight according to the Institute of Medicine guidelines and concluded that gestational weight gain guidelines should be modified for severity of obesity status (Faucher & Barger, 2015).

Tanda, Salsberry, Reagan, and Fang (2013) employed a descriptive observational research design to examine the association between maternal pre-pregnancy obesity and cognitive scores of their offspring during the early primary school age. Tanda et al. (2013) concluded that a significant association exists between maternal pre-pregnancy obesity and child cognitive test scores, and those who lived in a disadvantaged environment during postnatal stages were mostly affected.

Sen et al. (2013) explored pregnant woman who are obese and the association of infection during pregnancy, which has been identified to be a serious health issue that could harm both the mother and fetus. The cross-sectional case-controlled design study was intended for the exploration of obesity effects on the maternal blood immune functions (Sen et al., 2013). The study consisted of 30 people with 15 participants categorized as being lean or normal weight, and 15 participants categorized obese subjects (Sen et al., 2013). Sen et al. (2013) demonstrated that the weight gain at 28 weeks of pregnancy of women who were lean or normal was statistically significant compared to the weight gain of obese women during 28 weeks of pregnancy. Sen et al. (2013) also concluded that obese women have significantly lower CD8+ T cell than women who are lean or normal weight, and a significant negative correlation was identified for the obese group (Sen et al., 2013). They concluded that the findings are indicative of the potential increased rates or risks of infection observed in obese pregnancy (Sen et al., 2013).

Pignon and Truslove (2013) examined the impact of obesity to an increased rate of caesarean section. Pignon & Truslove (2013) employed a systematic literature search strategy and used the patient/problem, intervention, comparison, and outcome methodology to pull articles from 2000 and 2011. From the analysis, the researchers found a 27.8% cesarean rate among obese women and 10.8% among non-obese women (Pignon & Truslove, 2013). Based on the study's findings, Pignon & Truslove (2013) suggested that maternal obesity is associated with elevated BMI, and as a pregnant woman's weight increases from obesity to morbidly obese status, subsequent risk of cesarean was highly likely. Overall, there were implications indicating that reduction of obesity levels in pregnant women is an important factor in decreasing the rate of cesarean cases (Pignon & Truslove, 2013).

Bar, Kovo, Schraiber, and Shargorodsky (2017) investigated placental histopathology for lesions that are associated with maternal and fetal circulation abnormalities in obese pregnant women. This study consisted of 332 pregnant women separated into three groups; the non-obese metabolically healthy, obese metabolically healthy, and obese metabolically abnormal subjects (Bar et al., 2017). The investigators concluded that placental weight was significantly higher in the obese metabolically healthy women compared to non-obese metabolically healthy women (Bar et al., 2017). Maternal vascular supply also significantly varied across groups that had a high rate in both the obese women without metabolic abnormalities and obese metabolically abnormal subjects when compared to non-obese metabolically healthy women (Bar et al., 2017). Bar et al. (2017) concluded that obesity is associated with an increased rate of placental vascular abnormalities and has more adverse effects on fetal vascular circulation than the maternal vascular supply.

Adamo et al. (2013) conducted a two-arm parallel group randomized controlled trial in Ottawa. The study was conducted to explore the feasibility of whether maternal obesity and/or high gestational weight gain is associated with downstream child obesity (Adamo et al., 2013). Adamo et al. (2013) concluded that over the long-term, children born large for gestational age (birthweight >90th percentile) were exposed to a compromised intrauterine environment that is a product of maternal obesity and or excessive gestational weight gain. These researchers also indicated that these children are at increased risk of developing obesity and metabolic syndrome (Adamo et al., 2013).

Lagerros, Cnattingius, Granath, Hanson, and Wikström (2012) examined gestational diabetes mellitus (GDM) and the role of the mother's birthweight using a cohort of 323,083 women. The BMI was used to assess the related risk of gestational diabetes (Lagerros, Cnattingius, Granath, Hanson, & Wikström, 2013). There was an increased risk of gestational diabetes among women who were considered to be born at either high or low birthweight for gestational age (Lagerros et al., 2013). As a result, they iterated the need to maintain a normal healthy weight (Lagerros et al., 2013).

Health Literacy and Obesity

To advance meaningful and sustainable intervention approaches in public health or epidemiological settings, maintaining informed health programs that create opportunity for continuity in health awareness for risk factors associated with health outcomes are important elements in health promotion, measure efforts. Lupattelli, Picinardi, Einarson, and Nordeng (2014) conducted a multinational, cross-sectional, internet-based study to assess the association between health literacy and perception of teratogenic risks and healthy behavior during pregnancy. Lupattelli et al. (2014) evaluated 4,999 women who were pregnant between October 1, 2011, and February 29, 2012, by maternal sociodemographic, medication use, risk perception, beliefs, and non-adherence. Lupattelli et al. (2014) concluded that women with low health literacy were at higher risk of adverse health outcomes because of low perception for medication adherence such as penicillin and swine flu vaccine as they had negative beliefs about these medications. Women with low health literacy were also found to be more non-adherent to pharmacotherapy compared to those with high health literacy and health literacy was significantly associated with maternal health behaviors regarding medication beliefs and non-adherence, and supported the idea that health literacy may potentially impact prenatal nutrition behavior (Lupattelli et al., 2014).

According to Roberts, Bodnar, Patrick, and Powers (2012), evidence has shown that obesity increases the risk of preeclampsia and was identified to be present in 30% of cases within the United States. In support of preeclampsia and assessing an education tool, You, Wolf, Bailey, and Grobman (2012) conducted a randomized controlled trial with 120 women to explore the improvement processes of patient understanding of preeclampsia. A preeclampsia education tool and pamphlet designed by the American College of Obstetricians and Gynecologists was used to assess patients' knowledge on preeclampsia through a questionnaire survey (You, Wolf, Bailey, & Grobman, 2012). Individuals assessed with the preeclampsia education tool were compared to those evaluated with the pamphlet-based education (You et al., 2012). You et al. (2012) discovered that women who used the preeclampsia education tool scored significantly higher on the questionnaire than those who only read the pamphlet. Based on these findings, the investigators concluded that exposure to the graphics-based education tool promoted greater knowledge about preeclampsia in comparison to those exposed to standard reading materials or no education (You et al., 2012). This study supported the need to educate women on preeclampsia and the risk factor of maternal obesity as it affects all forms of preeclampsia during their gestation period (Roberts et al., 2012).

Lopez et al. (2014) conducted a study to explore how African American obese women consisted of diverse weight. This study involved in-depth interviews with African American women who were considered to be in weight categories of healthy, overweight, and obese status, which was defined by the BMI of individual participants. The community-based organization physically housed in-depth, face-to-face interviews, which were conducted in a range of 30 minutes and two hours (Lopez et al., 2014). This approach was used because a more conversational technique allows the interviewer to develop a rapport with the participant and more easily discuss the sensitive topic (Lopez et al., 2014). In order to assess inter-rater reliability of 85%, a second reviewer coded the interviews independently (Lopez et al., 2014). The weight definitions seemingly varied between individuals in the various weight categories (and Lopez et al (2014) identified that the interpretation of obesity posed subjective and interpretive discrepancies among various women in the weight group. Lopez et al. (2014) concluded that the tailored interventions could better resolve the division between African American women's perceptions and public health recommendations.

Krans and Chang (2012) conducted a study among low-income African American women to identify beliefs regarding exercising during pregnancy. A qualitative study was employed to explore African American women's perspectives and beliefs regarding exercise during pregnancy by conducting a series of focus group interviews, which consisted of 34 participants (Krans & Chang, 2012). Krans and Chang (2012) concluded that African American women defined exercise as an activity of daily living such as housework and childcare verses the view that it is something done outside of a normal house routine. Krans and Chang (2012) further concluded that African American women who are active at work or with their children might be reluctant to take additional time to perform traditional types of exercises. As a result, Krans and Chang (2012) concluded that providers should routinely discuss physical activity and gestational weight gain with their patients.

Using a cross-sectional research design, Brooten, Youngblut, Golembeski, Magnus, and Hannan (2012) explored the idea of perceived weight gain, risks, and nutrition in pregnancy within five racial groups. In this study, 54 participants who were < 20 weeks gestation were evaluated (Brooten, et al., 2012). In the study, 30% of women were overweight or obese, 57% were Caribbean black women, while 50% were African American (Brooten et al., 2012). Brooten et al. (2012) concluded that education was needed to raise awareness of risks of pre-pregnancy weight and excessive weight gain for mothers and infants and suggested the need for nutritional counseling to aid in the reduction of poor dietary food intakes and to increase focus on awareness and education on healthy dietary food intake choices.

Wilkin, Katz, Ball-Rokeach, and Hether's conducted a study that explored communication resources that aided in obesity prevention among 294 African American and 304 Latino residents within the urban community of Crenshaw, South Los Angeles, California. The method used for this study consisted of a 53-57 minute telephone survey (Wilkin et al., 2015). The first hypothesis predicted that connections to the neighborhood storytelling network would positively relate to levels of exercise and healthy eating, and was identified to be meaningful as researchers found a significant association with exercise or physical activity but not fruit and vegetable consumption. Wilkin et al. (2015) concluded that the ideology that family interaction would be positively correlated to obesity prevention behaviors was supported and positively associated with a resident’s exercise frequency and behavior, i.e., fruit, and vegetable intake.

Mobley et al. (2014), examined changes in maternal health literacy progression among low income, high risk, rural perinatal, African American and White women. These participants received home visits by registered nurse case managers (all African American) throughout the Enterprise Community Health Start (ECHS) program. Mobley et al. (2014) employed a retrospective cohort design, which consisted of existing records for women served by ECHS, which also included a pre-post comparison of prenatal to initial and to final postpartum (Mobley et al., 2014). The participants involved women with first case management experience and who were admitted to case managed after July1st, 2005, and had one prenatal and one postpartum Life Skills Progression (LSP) assessment (Mobley et al., 2014). Mobley et al. (2014) concluded that depression might be a chronic underlying problem for women undergoing high-risk pregnancies as well as a deterrent to women’s success (Mobley et al., 2014). However, the length of case management provided was essential to their success and was a contributor to women maternal literacy progression (Mobley, & et al., 2014).

Intervention and Management Approaches to Obesity

Evidence-based intervention measures and management approaches are necessary for reducing/mitigating the burdens (monetary and non-monetary) of obesity and its associated health and social consequences. Rundell and Panchal (2017) conducted a study to evaluate preterm labor prevention and management. The basis for the study was the notion that within the United States, spontaneous preterm delivery was the leading cause of neonatal morbidity and hospitalization during pregnancy (Rundell and Panchal, 2017). Preterm labor was defined as a progressive dilation and cervical effacement alongside regular uterine contractions (Rundell and Panchal, 2017). Antenatal progestogen therapy was recognized as an effective intervention strategy to decrease the risk of recurrent preterm delivery among women with a single gestational pregnancy and history of spontaneous pre-term labor (Rundell & Panchal, 2017). Rundell and Panchal (2017) identified the use of tocolytic agents as a mitigation method or management approach for women with preterm contraction and in prolonging the time to delivery. Researchers Rundell and Panchal (2017) further indicated that even with several trials conducted on the intervention approaches, there are no studies that showed that antibiotics' use during preterm labor served as an effective method to delay delivery and reduce morbidity. Antibiotics or group B streptococcuprophylaxis was concluded to have no effect on women with premature rupture of membranes (Rundell and Panchal, 2017).

Harrison, Skouteris, Boyle and Teede (2017) evaluated ways to prevent obesity across the preconception, pregnancy, and postpartum cycles and ways to implement the research into practice. The need to address and mitigate the increasing cycle of weight gain has been a reason for the push of preventive measures at the forefront of the international public health agenda (Harrison et al., 2017). While most research has focused on antenatal lifestyle intervention to prevent excessive weight gain and address obesity prevention, there was a lack in research that addresses crucial barriers on the hard-to-capture target populations, limited engagement opportunities, and those that are not connected well to the healthcare systems (Harrison et al., 2017). Harrison et al. (2017) proposed that creating positive impacts are equally important as the creation of knowledge and must be implemented and translated into changes in practices and policy. There were seven steps suggested to the intervention framework, which were identified.

The ‘Formative Research’ step entailed researchers and stakeholders engaging (Harrison et al., 2017) on how to maximize health outreach effectively through practices and programs. The ‘Knowledge Synthesis’ step involved the synthesizing of relevant guidelines and research evidence (Harrison et al., 2017). The ‘Knowledge Generation’ step consisted of a consolidation of the first two steps (Harrison et al., 2017). The ‘Implementation Research’ step used strategies to transfer and scale the evidence-based approaches into practice in real-world settings following the knowledge synthesis stage (Harrison et al., 2017). The ‘Dissemination Scale–Up’ step involved the ways information and resources were distributed to spread knowledge and promote evidence-based interventions (Harrison et al., 2017). The ‘Evaluation’ step entailed the utilization of existing frameworks in monitoring outcomes via registries (Harrison et al., 2017). Lastly, the ‘Extension’ step applied to the critical stages such as preconception and postpartum (Harrison et al., 2017).

Researchers Harrison et al. (2017) indicated that women of reproductive age are a high-risk group for accelerated weight gain and obesity (Harrison et al., 2017). Antenatal prevention should be implemented during the critical window stages of preconception, pregnancy, and postpartum as these stages drives the vulnerability and susceptibility of health risks was also concluded by the researchers (Harrison et al., 2017).

Ainscough, Kennelly, Lindsay, O'Sullivan, and McAuliffe (2016) conducted a study to explore the impact of a smartphone application named 'mHealth' by supporting antenatal healthy lifestyle and intervention on the behavioral stage of change among overweight and obese pregnant women. In this study, 98 participants with BMI ≥ 25 and ≤ 40 kg/m2 were evaluated (Ainscough et al., 2016). Ainscough et al. (2016) concluded that overweight and obese women who are pregnant used the intervention to make positive health behavior changes The app 'mHealth' also provided support to assist women in transitioning from the stages of contemplation/preparation to the maintenance of the positive behavior (Ainscough et al., 2018). Ainscough et al. (2018) suggested that if sustained, the app had the potential to promote positive pregnancy outcomes as well as long-term health behaviors for both the mother and unborn child.

Herring et al. (2016) conducted a study .using a two-arm pilot randomized clinical trial, in order to explore possible measures for the prevention of excessive gestational weight gain among African American woman. Herring et al (2017) evaluated 66 participants who were socioeconomically disadvantaged African American pregnant women. The participants received either usual care or experienced behavioral interventions, which included behavior change support, bi-weekly health coaching calls, and skills training (Herring et al., 2016). Herring et al (2016) concluded that lower prevalence of excessive gestational weight gain was due to the intervention.

Salihu et al. (2016) similarly examined the approach on how to improve health outcomes among low-income African American women. In the study, the researchers employed a community-based participatory research approach using 49 participants in Tampa Florida, USA (Salihu et al., 2016). Salihu et al. (2016) showed that there was a decrease in waist circumference, BMI level, and higher quality of life) and women with a higher BMI had success and gained higher quality of life. Salihu et al. (2016) concluded that an intervention group through the community-based participatory research is useful in the obese pregnancy community.

Nutritional Implications of Maternal Obesity

Furthermore, the assessment of the association between maternal obesity nutritional links has been demonstrated in many publications. Saad et al. (2016) evaluated the effects of antenatal exposure to a high fructose diet on an offspring's development of metabolic syndrome. This study used pregnant dams, which were randomly selected and allocated a fructose solution (Saad et al., 2016). This was the only drinking fluid from day 1 to pregnancy and delivery, and after the weening process a regular diet was implemented and an evaluation was conducted at one year of life (Saad et al., 2016). Saad et al. (2016) hypothesized that high-fructose diet in pregnancy leads to fetal programming of hypertension, insulin resistance, and obesity in adult offspring. The findings from the study suggested that the maternal weight and average weight at birth were similar between the two groups. Offspring of both the male and female fructose group had higher peak glucose, and intraperitoneal arterial pressure compared to the control group (Saad et al. 2016). Ultimately, they concluded that the fetal programing was more pronounced in the female offspring and by limiting the intake of high fructose, enriched diets in pregnancy may have a significant impact on long-term birth (Saad et al. 2016).

Morrison et al. (2012) suggested contributing factors to the development of diseases such as Gestational Diabetes Mellitus (GDM) stemmed from diet quality and nutritional lifestyle. Morrison et al. (2012) assessed the Australian diet quality among the selected target pregnant women who have GDM and concluded that although there was an increased risk of Type II diabetes, the overall diet quality measures of female subjects who participated in the study had a poor diet lifestyle. The diet score was based on the Australian recommended food score .Morrison et al. (2012) concluded that women with GDM should be targeted for interventions that aim to achieve a postpartum diet that is consistent with the guidelines for chronic disease preventions.

O’Brien et al. (2017) employed a qualitative method of 22 participants to explore the influence of overweight/obese pregnancy on food choices and physical activity behaviors, and to determine the effects of the behaviors on pregnancy. The measures explored in this study were known barriers to healthy eating and physical activity, and the facilitators to healthy eating and physical activity among the participants (O’Brien et al., 2017). O’ Brien et al. (2017) concluded that personal and social environment factors heavily affected food choices and physical activity. Implications from this study also showed that pregnancy is a powerful stimulus and could cultivate positive changes in food choice due to the desire for a healthy pregnancy and intrinsic motivation (O'Brien et al., 2017).

Summary and Conclusions

Overall, the body of literature reviewed for this research topic addressed different aspects of obesity. The key elements of obesity covered in this literature review included the risk of obesity, plausible biological marker for obesity, social determinants, health outcomes, health literacy, intervention/management approaches, and nutritional implications. All these determinants or indicators are relevant when considering and conducting any research inquiry on obesity, as proposed in this study. The literature review process informed better understanding and assessment on the issue. The conclusion drawn from each of the literature reviewed was consistent and showed a negative or adverse health effect of obesity. However, none of the literature specifically addressed the aspects of various levels of obesity (moderate, severe, and very severe) and its effects on preterm birth and neonate birthweight. Thus, the lack of literature covering the levels of obesity and its effects on preterm birth and neonate birthweight showed that there is a need for research on this topic. This also supported the need to conduct studies that will allow researchers to identify the direct and/or indirect implications of preterm birth and neonate birthweight based on mothers' status of prenatal obesity level. The information provided in the majority of the reviewed literature supported socioecological model as one of the important frameworks that could be used to address the research questions posed in this study. The research design and methodology employed in this study will be explored in detail in Chapter 3.

Chapter 3: Research Method

In previous studies, some of the factors influencing obesity-related adverse health outcomes among pregnant women and newborns/infants were investigated. However, how the different categories of obesity (moderate, severe, and very severe) affect prenatal status on preterm-birth and neonate birthweight had not been extensively studied. In the current quantitative study, a cross-sectional design was used. The data for this study were collected from a secondary source. In the secondary data, a survey-driven data collection approached in a surveillance project known as Pregnancy Risk Assessment Monitoring System (PRAMS) by the CDC and state health departments was employed covering all U.S. births. Based on the nature of the study and research questions, the application of a quantitative approach was appropriate to address the identified gap in the literature regarding the associations between moderate, severe, and very severe maternal obesity and preterm birth and low birthweight among women of reproductive age.

The social-ecological theory was the conceptual basis through which the observed phenomenon was examined with an in-depth explanation of the findings regarding the specified obese categories among women of childbearing age and preterm birth and neonate birthweight. In the first section of this chapter, the research design, study rationale, and resource constraints are described. Then the methodology and relevant operational constructs related to key variables in the study are discussed. I also describe the data analysis plan, threats to validity, and ethical procedures.

Research Design and Rational

In this quantitative study, a cross-sectional research design was implemented. A cross-sectional design is commonly applied in a prevalence study (Creswell, 2009). It was therefore appropriate to apply a cross-sectional design in evaluating the difference between the prevalence rate of preterm birth among women of reproductive age who are moderately obese, severely obese, or very severely obese and those with a normal body weight. Assessing the difference in the prevalence rate between the specified groups produced a directional indication (positive, negative, or no association) regarding the association between the three categories of obesity (moderate, severe, and very severe) and preterm birth. Also, using a cross-sectional design, the odds ratio risk estimation could be calculated (see Creswell, 2009). In this study, the dependent variables were preterm birth and neonate birthweight. The levels of measurements for preterm birth and neonate birthweight were nominal/categorical and ordinal, respectively. The nominal level for the preterm birth health outcome was either a yes or no response to the question of whether a woman had a preterm delivery. The neonate birthweight measurement was an ordinal level: low (≤ 2500 grams), normal ≥ 2500 grams <3000grams). The independent variables were the categorized status of obesity (moderate, severe, and very severe). The obesity category was an ordinal variable. The reference groups for body weight were normal body weight and moderate obese body weight. These two groups (normal weight BMI 18.5 to 24.9 and moderate obese BMI 30 to <35) were used to assess whether maternal severe obese (BMI 35 to <40) and very severe obese (BMI ≥ 40) status significantly predicted preterm birth and low neonate birth outcomes after accounting for the confounders identified in this study as follows:

- age,
- education,
- income,
- marital status,
- race, and
- ethnicity.

A cross-sectional study design is not explicitly tied to any research method or approach (Creswell, 2009). The primary element that determines the type of research design, research method, and statistical strategy employed in a study is the research question (Creswell, 2009). The predictor and outcome variables or the confounder and covariate levels of measurements determine the type of statistical approach most appropriate for the analysis (Creswell, 2009). Each analytical approach has assumptions that must be met before it can be used in any statistical analysis (Creswell, 2009). Most if not all of the assumptions affect the primary predictor and outcome variables (Creswell, 2009). Therefore, the data set must contain variables that fit or can be transformed to meet the desired assumption (Creswell, 2009).

Methodology

In this study, the data were obtained from a secondary data set provided by the CDC. The CDC and state health department used the PRAMS system to collect state-specific population-based data on maternal attitudes and experiences prenatal, pregnancy, and postpartum (CDC, 2018). As a result, the research design, research method, and the variables' levels of measurement were fixed based on the original data collection techniques. For this reason, the selected research design and method used in this study was based on a predetermined approach, which reflected the secondary data methodologies used by the original collector of the data. The use of secondary data in this study did not require major time constraints. This process was a time- and cost-saving approach. However, the research question to be addressed was limited to the contents of the variables captured in the secondary data set (see Creswell, 2009). Research questions outside the limit of the measured variables within the secondary data set cannot be addressed (Creswell, 2009). All variables identified were confounders because each influenced or interacted with both obesity status and preterm or neonate low birthweight. For instance, in a cross-sectional study, Kurspahić-Mujčić1 and Zećo (2017) showed that socioeconomic and demographic factors were associated with abdominal obesity among women of childbearing age. The sample population used in the current study was also within the parameters of the sample size captured in the secondary data set.

Population

The study included a one-gender outcome assessment that involved only women. Men were excluded from the unit of analysis. The eligibility age for enrollment and selection in the study was 18-39 years. The age criteria (18-39 years) was selected because researchers estimated the prevalence of obesity among women ages 20-39 years at 34.4% and 42.1% for women ages 40-59 years (Ogden, Carroll, Fryar, & Flegal, 2015). The eligibility criteria included women of all races. However, they were required to have been living in the United States. The eligibility criteria also included women of normal weight and obese status, but excluded the overweight status (BMI 25 to <30). The source of the secondary data set was PRAMS. The PRAMS data set was accessed by request via the CDC PRAMS application process (See Appendix C).

Data Analysis Plan

The PRAMS data set contained information about women of reproductive age (CDC, 2017). The group targeted in this study was women between the age of 18-39 years, who resided in the United States, and delivered at least one child. The BMI categories were normal weight (18.5 to 24.9), moderate obesity (30 to <35), severe obesity (35 to <40), and very severe obesity (≥40). The BMI for normal weight was the reference category against which the moderate, severe, and very severe obese categories were compared in the analyses. Information produced from the statistical analysis of these women selected across the United States from all races and ethnicities were analyzed to determine if obesity categories predicted preterm birth and neonate birthweight. In order to use the PRAMS' data set to address the research questions posed in this study, the data was prepared to reflect the desired levels of measurement for the variables (predictor variable, outcome variable, and covariate/confounders) required for the statistical analysis. Coding and recoding of the data was needed for obese categories (moderate, severe, and very severe status), age, and education levels. The BMI range for the specified bodyweight categories were; normal weight (BMI = 18.5 ≤ 24.9), moderate obese (BMI = 30 < 35), Severe obese (BMI = 35 < 40), and very severe obese (BMI = ≥4). Women who were categorized as underweight (BMI <18.5 and overweight (BMI 25 to 29.9) were excluded due to the focus of this study being women of obese statuses and normal weight. The Statistical Package for Social Sciences (SPSS) software was used for the statistical analysis. At the end of the statistical analysis, decision were made on whether to reject or fail to reject the null hypothesis based on the significant level generated in the analysis for each research question.

Study Power and Sample Size

G*Power software was used to calculate the appropriate minimum sample size required for this study. The estimated sample size criteria was based on the z test family; logistic regression statistical test; A priori parameters with 0.5 (5%) alpha; 0.8 (80%) statistical power; two tail input parameters; normal distribution assumption; and 1.3 odds ratio (effect size) predetermination parameters. The logistic regression was used for this study. In order for the logistic assumptions to be met, the dependent variables must be categorical and the independent variable should be either a categorical or a quantitative variable or both (Ellis, 2010; Forthofer, Lee, & Hernandez, 2007). In this study the preterm birth and neonate birthweight (outcome/dependent variables (DV) were categorical variables with two groups neonate birthweight of low (<2500 grams) and normal birthweight (≥2500 grams ≤3999 grams). The independent variable were body weights (normal weight, obese statuses—moderate, severe, and very severe) which were ordinal and therefore, this study met the logistic regression assumption. Other assumptions include normality and having more than two categories of dependent variables, as specified above (Ellis, 2010; Forthofer, Lee, & Hernandez, 2007).

For this study, the total amount of data available from the PRAMS data set consisted of 141,859 participants. In order to reflect the minimum sample size estimation required to produce inferential results with a statistical power of 80% (see Appendix A); a random sample minimum of 721 was required from this secondary data set (PRAMS data set) however, the entire data set was used. With at least a statistical power of 80%, a Type II error (a false negative result) was less likely to occur (Creswell, 2009). According to Jacob Cohen, an 80% probability of detecting an effect when there is an actual effect to be detected is an acceptable statistical standard and approach (Cohen, 1988). Similarly, a Type I error (false positive result), is substantially reduced by simultaneously increasing the total sample size required in a study (Creswell, 2009). The predetermined statistical metrics set for this study analysis are as follows:

- A 0.05 (5%) alpha value (α) (Type I error value); 0.95 (95%) level of confidence; 0.2 (20%) beta value (β) (Type II error value); and 0.80 (80%) statistical power (P).
- The predetermined effect size or magnitude of the effect, in this case, the odds ratio (OR) value was set at 1.3 for both preterm birth and low birth weight outcomes. Setting an OR value at 1.3 for the G*Power estimation means that at minimum, a 1.3 odds ratio effect should be observed in this study using a minimum sample size of 721 women for a two-tail logistic analysis after accounting for the confounders. Also, by using a two-tail instead of a one-tail statistical approach for the analysis, a bidirectional observation could be made on the effects of obesity categories on preterm birth and neonate birthweight rather

than a unidirectional assessment. In this study, it was possible that the analysis could show that the three obese statuses (moderate, severe, and very severe) predicts preterm birth and neonate birthweight (enhancers or positively correlated). It was also possible that the analysis could show that the three obese statuses (moderate, severe and very severe) predicts preterm birth and neonate birthweight as a protector factors (negatively correlated), or perhaps, do not have any effect on the outcomes at all (neutral) compared to the control group. There was no specific expectation towards any direction for the proposed study, due to limited information specifically on obese category's differential additive effects.

Sampling and Sampling Procedures

The sample in the secondary data set (PRAMS') was randomly selected (CDC, 2017). Between 1300-3400 women were sampled per year from each of the participating states (CDC, 2017). The women included must have had a recent live birth (CDC, 2017). Women from high-risk populations were targeted more than those with low risk factors such as income, age, race, education, and marital status (CDC, 2017). The sampling technique, therefore, helps to ensure adequate representation of the participants for the data analysis (CDC, 2017). The population of interest consists of mothers who were residents of the state they gave birth to a live-born infant during the surveillance period of 2012-2015. Vital records and birth certificate file serves as the best available source of sampling frame representing live births (CDC, 2017). PRAMS included mothers whose infants died in the sampling frame because of the importance of learning about the maternal behaviors of mothers as it related to infant deaths (CDC, 2017).

The exclusion criteria were stillbirths, fetal deaths, and induced abortions because reporting systems for these outcomes were not routinely in place in many states, and the standard definitions for these outcomes varied widely for mothers and babies (CDC, 2017). The questionnaire was also sensitive to this issue and had little difficulty in eliciting responses from this group of women (CDC, 2017).

The following contact methods were used to contact the participants:

• Preletter: Introduced PRAMS to the mother and informed her that a questionnaire would soon arrive.

• Initial Mail Questionnaire Packet: All sampled mothers received the packet three to seven days after the preletter and contained the contents as described below.

• Tickler: Served as a thank you and a reminder note and sent seven to ten days after the initial mail packet.

• Second Mail Questionnaire: I: If the mother did not respond within seven to fourteen days the tickler was sent, the nonrespondents would receive this packet.

• Third Mail Questionnaire Packet: All remaining nonrespondents would receive the packet seven to fourteen days after the third mail questionnaire packet was sent.

• Telephone Follow-up: A Telephone follow-up was initiated for all mail nonrespondents seven to fourteen days after mailing the last questionnaire (CDC, 2017).

Those who showed interest upon receiving the initial letter were selected and contacted for the initial recruitment interview via the phone and if there was no response upon repeated mailings or participation requests, the nonrespondent women were contacted and interviewed by telephone (CDC, 2017). The data collection procedures and instruments were standardized for comparisons between states (CDC, 2017).

Data Collection

The data collection process for this study entailed the collection of secondary or archived data by the CDC PRAMS, which is part of the Division of Reproductive Health. The CDC PRAMS' secondary data collection process was achieved with the cooperative and collaborative efforts of the state health departments across the United States. The data collection process is still a continuous state-based surveillance system intended to capture information about maternal behavior, attitudes, and experiences among women during the prenatal and postpartum periods of the pregnancy. For my study, the 2012-2015 CDC PRAMS data set was used. The specifics of the 2012-2015 CDC PRAMS data used for this study included some customized information, which were restricted from public access. The customized information required a special review and approval process by the CDC PRAMS team who assessed this study's rationale for its use before the de-identified information was approved.

CDC PRAMS original sample size estimate of 141,859 participants exceeded the minimal G*Power sample size estimate of 721 participants required for this study. The inclusion criteria for this study were all women who had a live-birth infant delivery and were between the ages of 18-39. For the population sampling of the CDC PRAMS, each participating state jurisdiction sampled approximately 1300 to 3400 women who lived in the United States and had a live-birth infant (CDC, 2018). The authentication process for the inclusion criteria among the sampled population includes verification of birth certificates or records (CDC, 2018). Each of the forty-seven states (as well as Ohio and California who no longer participate), the District of Columbia, New York City, Puerto Rico, and the Great Plains Tribal Health Chairman's Health Board stratified their sample by maternal age, race, ethnicity, geographic area of residence, and neonate birthweight (CDC, 2018).

The data collection approach used was mixed mode mail and a telephone survey (CDC, 2018). The Don Dillman survey approach, principles, and best practices were incorporated in the mail and telephone survey methodologies (CDC, 2018). As mentioned above in detail the CDC PRAMS surveillance data collection performed were as follows:

- A 'pre-letter' was sent to eligible women to inform them about PRAMS and solicit participation and inform them a questionnaire would be sent following the initial inquiry contact.
- An initial mail questionnaire was sent in the form of a packet to the sampled mothers within 3-7 days after the pre-letter was sent.
- A tickler served as a thank you and reminder note was sent within 7-10 days of the initial mail packet.
- A second questionnaire mail packet was sent to all sampled mothers who did not respond to the initial questionnaire. within 7 to 14 days after the tickler had been sent.
- The third questionnaire mail packet was sent to the remaining non-respondents within 7-14 days after the second questionnaire.

- To all non-respondents who were sent a mail, a telephone follow-up was initiated within 7-14 days after mailing of the last questionnaire (third questionnaire) (CDC, 2018).

The exclusion criteria for this study using PRAMS data were women who were 17 years and younger. Another exclusion criterion included were women who had a BMI value less than 18.5 and those with BMI value ranged 25.0 to 29.9, which included underweight and overweight women, respectively. The focus of this study was women with normal BMI and those who are obese. Women with normal BMI was the control group while those with obese status were the test group.

PRAMS surveillance project is a standardized data collection system, designed for state-specific and population-based approaches to understand maternal experiences and attitudes during pre-pregnancy, pregnancy and postpartum (CDC, 2018). This surveillance covers approximately 83% of births (CDC, 2018). The series of mailings that were sent out to participants started 2-4 months after the woman delivers her baby (CDC, 2018). The data collection cycle from the mailing of pre-letter to the closing period is 60-95 days (CDC, 2018). For approximately 4-7.5 months, each participating state drew a systematic sample of 100-200 women per month who had recent live births, which totaled approximately 1300-3400 women per year however; some states oversampled their population to ensure that they accounted for individuals at a higher risk (CDC, 2018). The overall response rate for the sampling was 70% (CDC, 2018).

Archival Data

The methodology used was standardized to allow comparisons among the states within the United States and optimize data usage for a single state or multistate purposes (CDC, 2017). There were two forms of data collections conducted by PRAMS; a survey methodology based on Don Dillman's research and mailed questionnaires with multiple follow up attempts, and a phone survey (CDC, 2017). The CDC used PRAMS model surveillance protocol) (CDC, 2017).

The series of the original PRAMS' mail cycle requests sent to women participants now being used in this study lasted about 2-4 months. The mail collection cycle or enrollment period lasted between 60 to 95 days. Each month, a stratified sample was drawn based on the following characteristics, maternal age, race, ethnicity, infant birthweight, and residence locale (CDC, 2017). From the birth certificate file, about 100-250 mothers a month, for a total of 1000-3400 annually were selected (CDC, 2017). The data was collected and managed through a web-based system (CDC, 2017). Through PRAMS Intergraded Data System (PIDS), information was tracked, and reports were generated. For access to the data set and the archives, a data permission request form was completed and submitted to CDC. Once approved, access to the data was granted through the CDC. Along with the data access request form, a data sharing agreement was also submitted; refer to the Appendix C for a copy of the form.

Table 2

Operationalized variables in the PRAMS data set

Variables	Variable type	Categories	Scale of measurement
Neonate Birthweight	Dependent	<2500 gram = Low Birthweight ≥2500 to <3999 grams = Normal Birthweight	Nominal/ categorical
Maternal BMI	Independent variable of interest	Normal (18.5-24.9), Moderate Obese (30 -<35), Severe Obese(35 - <40), Very Severe Obese (≥ 40)	Categorical/(Ordinal)
		Federal Poverty Level (0-21,330) Low Income (20,000-44,999- Middle Income (45,000-149,999) High Income (≥150,000)	Categorical/ (Ordinal)
Ethnicity	Independent	Hispanic or Non-Hispanic	Nominal
Race	Independent	1= Other Asian, 2 = White, 3 = Black, 4 = American Indian, 5 = Chinese, 6 = Japanese, 7 = Filipino, 8 = Hawaiian, 9 = Other Non-White, 10 = AK Native, 11= Mixed Race, N= Not Recorded	Categorical
Education	Independent	Elementary/ Junior High School (0-8 Yrs.), Some High School (9-11Yrs) Completed High School (12, Yrs.) Some College (13-15), College Graduate/ Higher (≥16)	Categorical/ (Ordinal)
Marital Status	Independent	1= Married, 2= Not Married, 3=Did not Participate	Categorical
Age	Independent	1 = 18-19, 2 = 20-24, 3 = 25-29, 4 = 30-34, 5 = 35-39	Interval

[1] Marital Status: Did Not Participate, are women who did not respond

Research Questions and Hypothesis

RQ1: Is obesity status (moderate, severe, and very severe) among women ages 18-39 years associated with a change in the prevalence of preterm birth when compared to women with a normal body weight?

H_{o1}: Obesity (moderate, severe, and very severe) among women ages 18-39 years is not associated with a change in prevalence of preterm birth when compared to women with a normal body weight are not different.

H_{a1}: Obesity (moderate, severe, and very severe) among women ages 18-39 years is associated with a change in prevalence of preterm birth when compared to women with a normal body weight.

RQ2: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese?

H_{o2}: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

H_{a2}: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

RQ3: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese?

H_{03}: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from who are severely obese.

H_{a3}: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese.

For RQ1, (Is obesity status (moderate, severe, and very severe) among women ages 18-39 years associated with a change in the prevalence of preterm birth when compared to women with a normal body weight?). A logistic regression analyses was used to address this question as it compared moderate, severe and very severe obese women prevalence of preterm birth with women of normal weight. The models that were built were unadjusted and the measure of association to calculate included OR and used a CI of 95%. This did not include one to identify if results were statistically significant. The estimation of prevalence was calculated using the following formula

Prevalence = Total number of cases/ Total number of population at risk

Standardization of the prevalence per 1000 women:

*Prevalence = (Total number of cases/Total number population at risk) *1000*

For RQ2, (What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese?), a logistic regression analyses was used to address this question as it compares moderate severe and very severe obese women prevalence of preterm birth with women of normal weight. The models that will were build were unadjusted and the measure of association to calculate included OR and used a CI of 95%. If results were identified to be statistically significant, all selected confounders previously described for this study were added and the effects on the preterm birth for the three categories of obesity (moderate, severe, very severe) were identified.

For RQ3, (What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese?) a logistic regression analyses was used to address this question as it compares moderate severe and very severe obese women prevalence of preterm birth with women of normal weight. If results were identified to be statistically significant, all selected confounders previously described for this study were added and the effects on neonate birthweight for the three categories of obesity (moderate, severe, very severe) were identified.

Threats to Validity

Internal and external validity issues are inherent in a cross-sectional design (Creswell, 2009). An External validity would not be established without maintaining an internal validity (Creswell, 2009). Some of the internal validity issues are linked to the design. Establishing a spatiotemporal sequence between an exposure and outcome or vice versa using a cross-sectional design approach is difficult (Creswell, 2009). In other words, it affects the ability to detect whether the exposure preceded or proceeded the outcome of interest. In this study, obesity occurred through a sustained process of cumulative behavior and lifestyle, and perhaps genetic predispositions and should be quantifiable long before pregnancy and given birth. Therefore, it is possible that obesity could occur way before preterm birth and neonate birthweight problems for a woman. However, it may not be possible to show using a cross-sectional study that a woman could have been predisposed to preterm birth or neonate birthweight problems by factors such as genetic defects other than the obesity status.

Internal validity could distort information and thus lead to a Type I, Type II error, or spurious or an erroneous conclusion (Crosby, 2013). Correlational effects are not necessarily causal (Creswell, 2009). A cross-sectional design in the absence of any experimental or quasi-experimental study could only be used to predict an inferential relationship and not a causal association (Creswell, 2009). The conclusions made in this study should not be extended beyond the target population implicated which are women within childbearing age of 18-39 who have had at least one child and are within the weight levels of moderate, severe or very severe obese. It should only be limited to the selected samples. In this study, selection bias is likely to occur. Since PRAMS did not provide any information about familial history of preterm birth or low birthweight among women included in the PRAMS' data, it could be possible that women used for this current study had a familial history of preterm birth or neonate birthweight or other obesity issues.

Ethical Procedures

An agreement to gain access to the data was documented (see Appendix B). To be granted access to the data set, all the ethical guidelines mandated by the CDC had to be met. Adherence to the Walden IRB processes also had to align with the CDC ethical standards for research involving human subjects. The Walden IRB was responsible for ensuring all research guideline compliance both for the university and for CDC/US federal regulation standards. In this study, IRB approval was required before collection of any data, including pilot data if applicable. I completed the ‘data use agreement’ form (Appendix D) for the permission to use the data for this study analysis. The data set used is de-identified by the CDC before receiving it. As such, names of the participants, address, locations, other personal identifiable information, and medical information are not included in the data set (CDC, 2017).

The data access was password protected such that only individual with authorized clearance could have access to the data (CDC, 2017). Confidentiality, protection of participant information, and any other necessary data compliance standards are essential ethical concerns addressed by the CDC before releasing the data (CDC, 2017). Unique identifiers in place of individual names or social security numbers were used in the data set to protect the participants’ personal information and safety. Other Health Insurance Probability and Accountability Act (HIPAA) regulations on personal health information were enforced.

Summary

The methodology, research design, and threats to validity were discussed in this section. The use of a cross-sectional design was applied to evaluate whether moderate, severe, and very severe obese conditions among women of reproductive age at any socioeconomic status or race are associated with preterm birth and neonate birthweight. The potential confounding variables identified in this study were age, education income, marital status, race and ethnicity. Because this study is not an experimental or a quasi-experimental research design-driven, it is not possible to assess causality of the risk. However, this study is critical as it may contribute to the advancement of effective health promotion and preventative measures among the targeted community as it relates to preterm birth and neonate birthweight risks. The analytical findings/results and the conclusions drawn will be discussed in Chapter 4 and 5 respectively.

Chapter 4: Results

Obesity is a risk factor for many diseases. In this current cross-sectional study, I investigated the association between three categories of obese status (moderate, severe, and very severe) and low neonate birthweight and preterm birth among women ages 18 and 39 years at all socioeconomic levels. Understanding the association between moderate, severe, and very severe obese statuses and low neonate birthweight and preterm birth could help delay, control, or prevent adverse health outcomes known to be associated with obesity. To address the research questions in the current study, the data analyses and results are described in this chapter. The data analyses and results begin with descriptive analyses and are followed by inferential analyses that address the research questions. The descriptive analysis section contains information regarding the frequency, percentage, and graphic representation of the sample population and all of the implicated variables (preterm birth, neonatal low birthweight, obesity status [moderate, severe obese, very severe obese], income, education maternal age, marital status, race, and ethnicity). The inferential analysis includes statistical analysis of beta values, significant values or *p* values, effect size (odds ratio), and confidence intervals for each of the research questions.

The following research questions and hypotheses were addressed in this study. The first research question addressed the prevalence of preterm birth between women who are moderately obese, severely obese, or very severely obese compared to women with a normal body weight. The second research question addressed the association between neonate birthweight of babies born from women who are severely obese compared to neonate birthweight of babies born from women who are moderately obese. The third research question addressed the association between neonate birthweight of babies born from women who are very severely obese compared to the neonate birthweight of babies born from women who are severely obese. All three research questions were addressed using a quantitative method and a secondary data set. The research questions and hypotheses are as follows:

RQ1: Is obesity status (moderate, severe, and very severe) among women ages 18-39 years associated with a change in the prevalence of preterm birth when compared to women with a normal body weight?

H_{o1}: Obesity (moderate, severe, and very severe) among women ages 18-39 years is not associated with a change in prevalence of preterm birth when compared to women with a normal body weight are not different.

H_{a1}: Obesity (moderate, severe, and very severe) among women ages 18-39 years is associated with a change in prevalence of preterm birth when compared to women with a normal body weight.

RQ2: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese?

H_{o2}: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

H_{a2}: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese.

RQ3: What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese?

H_{03}: There is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from who are severely obese.

H_{a3}: There is an association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese.

Results

The focus of this study was the assessment of the association between obesity status (moderate, severe, and very severe) and preterm birth and neonate low birthweight. In Table 3, confounders (income, education, age, marital status, race, and ethnicity) that were relevant to this study are listed.

Table 3

Study variables and variable type

Variables	Variable types
Preterm birth	Dependent variable
Neonate low birthweight	Dependent variable
Obesity levels (moderate, severe, very severe)	Independent variable
Income	Confounder
Education	Confounder
Age	Confounder
Marital status	Confounder
Race	Confounder
Ethnicity	Confounder

Descriptive Statistics

Table 4 and Figure 1 show the distribution of study participants. The total number of women surveyed was 141,859, and most of the women responded to the ethnicity question. Approximately 82% of the women identified as Hispanic. About 14% women were non-Hispanic while 4% women provided no response.

Table 4

Hispanic ethnicity distribution

	Frequency	Percent	Valid percent	Cumulative percent
Hispanic	116139	81.9	81.9	81.9
Non-Hispanic	20499	14.5	14.5	96.3
Missing value	5219	3.7	3.7	100.0
Total	141857	100.0	100.0	
Unknown ethnicity	2	.0		
Total	141859	100.0		

Note. Valid percent does not include missing values.

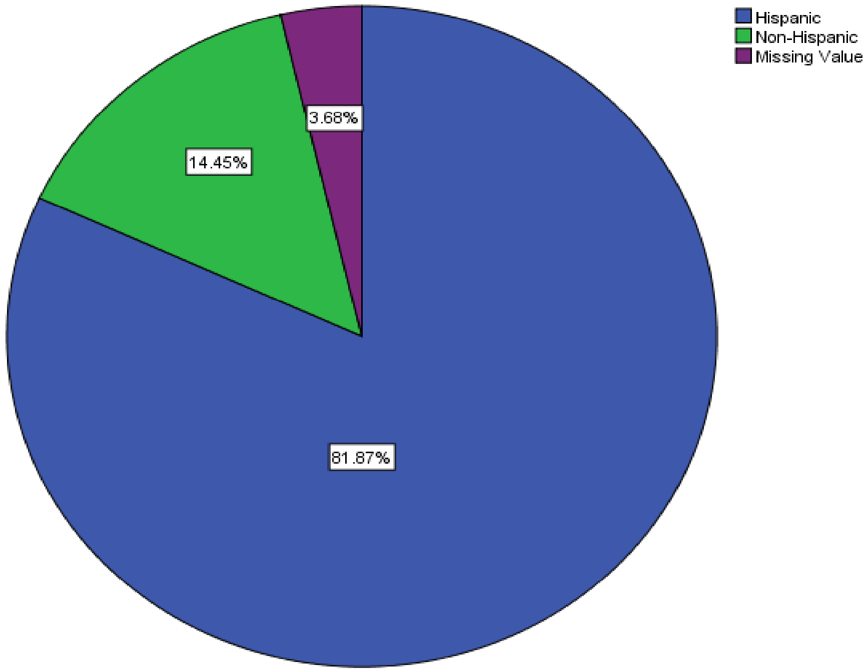

Figure 1. Hispanic ethnicity distribution

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Table 5 and Figure 2 illustrate the marital status of the participants. Approximately, 41% of women identified as not being married, but 59% of the women indicated that they are married and about 0.4% of the women provided no response to this survey question.

Table 5

Marital status

	Frequency	Percent	Valid percent	Cumulative percent
Married	83277	58.7	58.7	58.7
Not married	58016	40.9	40.9	99.6
Did not participate	566	.4	.4	100.0
Total	141859	100.0	100.0	

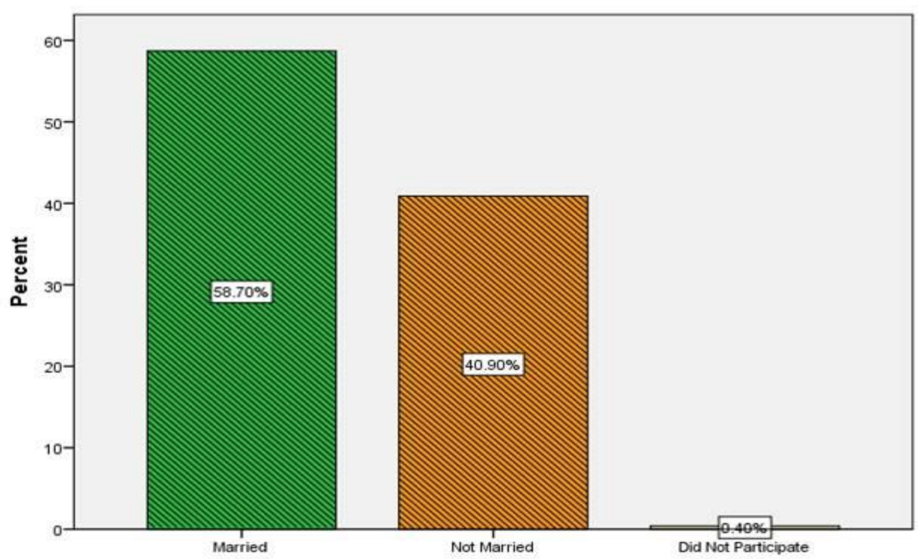

Figure 2. Marital status distribution

Table 6 and Figure 3 represents the maternal age of the participants within the inclusion criteria of 18-39. Of 141,859 women surveyed, approximately 5% were between the ages of 18 to 19 years old while 23% of the women were between the ages of 20 to 24 years old. Most women were between the ages of 25 and 29 years old representing about 30% of the survey population while women between the ages of 30 and 34 years old represented 28% of the surveyed population. Women between the ages of 35 and 39 years old represented 13% of the survey population.

Table 6

Maternal age groups

Age group		Frequency	Percent	Valid percent	Cumulative percent
	18-19 Yrs.	6958	4.9	5.2	5.2
	20-24 Yrs.	30932	21.8	23.0	28.1
	25-29 Yrs.	40851	28.8	30.3	58.5
	30-34 Yrs.	38234	27.0	28.4	86.8
	35-39 Yrs.	17716	12.5	13.2	100.0
	Total	134691	94.9	100.0	
Missing/ Women ages >39		7168	5.1		
Total		141859	100.0		

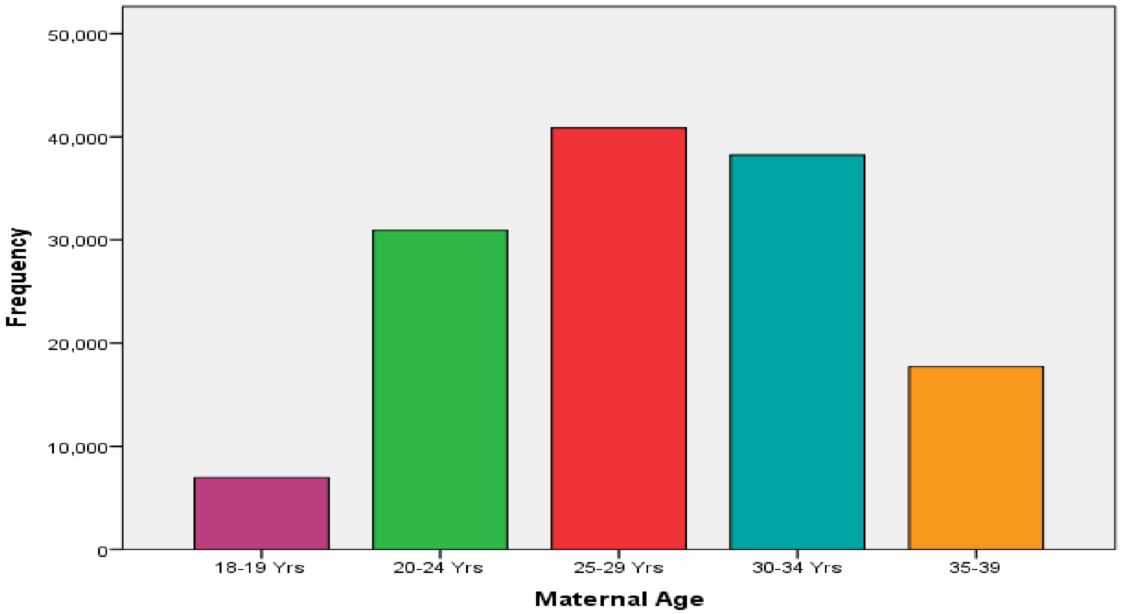

Figure 3. Maternal age distribution

Table 7 and Figure 4 show the maternal education of participants. Of 141,859 women, 140,216 of them responded to the education level survey. Approximately 3% of the women had no more than an elementary or junior high education and 12% of the women had some high school education. Women that completed high school were approximately 26% school while 29% of the women had some college education. Women who had college graduate degree or higher education represented 31% of the participants.

Table 7

Maternal education distribution

	Frequency	Percent	Valid percent	Cumulative percent
Elementary/ Junior High School	4376	3.1	3.1	3.1
Some high school	16144	11.4	11.5	14.6

Completed high school	35720	25.2	25.5	40.1
Some college	40449	28.5	28.8	69.0
College graduate/ Higher	43527	30.7	31.0	100.0
Total	140216	98.8	100.0	
Unknown	1643	1.2		
Total	141859	100.0		

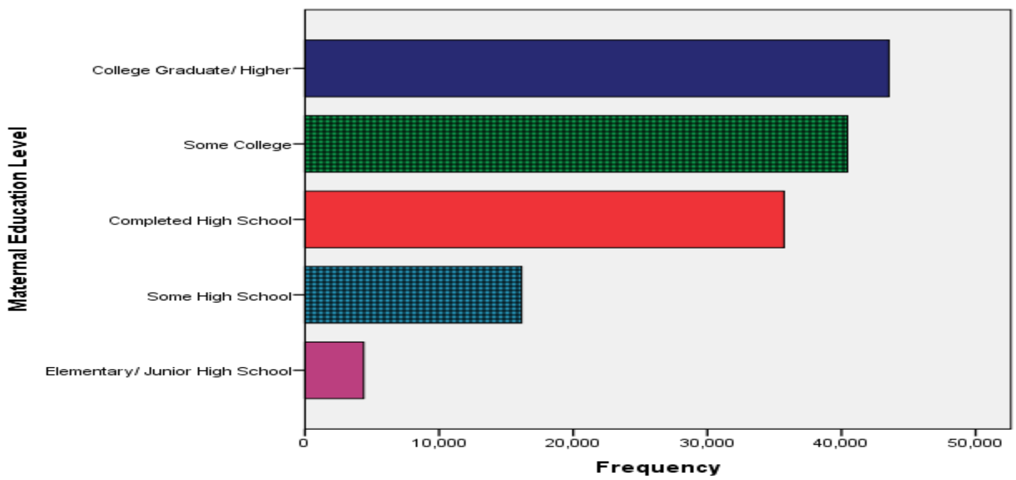

Figure 4. Maternal education distribution

Table 8 and Figure 5 show the maternal race distribution of the participants who were selected in this study. Of the total number of 141,859 women who were surveyed, 136,783 women responded to the survey question and indicated their racial group. Approximately 4% of the women identified themselves as Other-Asian race. About 61% of the women self-identified as White, 17% as Black, 3% as American Indian, 1% as Chinese, and 1% as Japanese. In addition, 1% of the women self-identified themselves as Filipino and 1% as Hawaiian. About 5% of the surveyed women self-identified themselves as Other-Non-White race, while 1% of the women were Alaskan Native, and 5% of a mixed race.

Table 8

Maternal race distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
	Other Asian	5885	4.1	4.3	4.3
	White	83686	59.0	61.2	65.5
	Black	23602	16.6	17.3	82.7
	American Indian	3381	2.4	2.5	85.2
	Chinese	1591	1.1	1.2	86.4
	Japanese	622	.4	.5	86.8
	Filipino	1811	1.3	1.3	88.2
	Hawaiian	1020	.7	.7	88.9
	Other-Non-White	7300	5.1	5.3	94.2
	AK Native	1738	1.2	1.3	95.5
	Mixed Race	6147	4.3	4.5	100.0
	Total	136783	96.4	100.0	
Race Unknown		5076	3.6		
Total		141859	100.0		

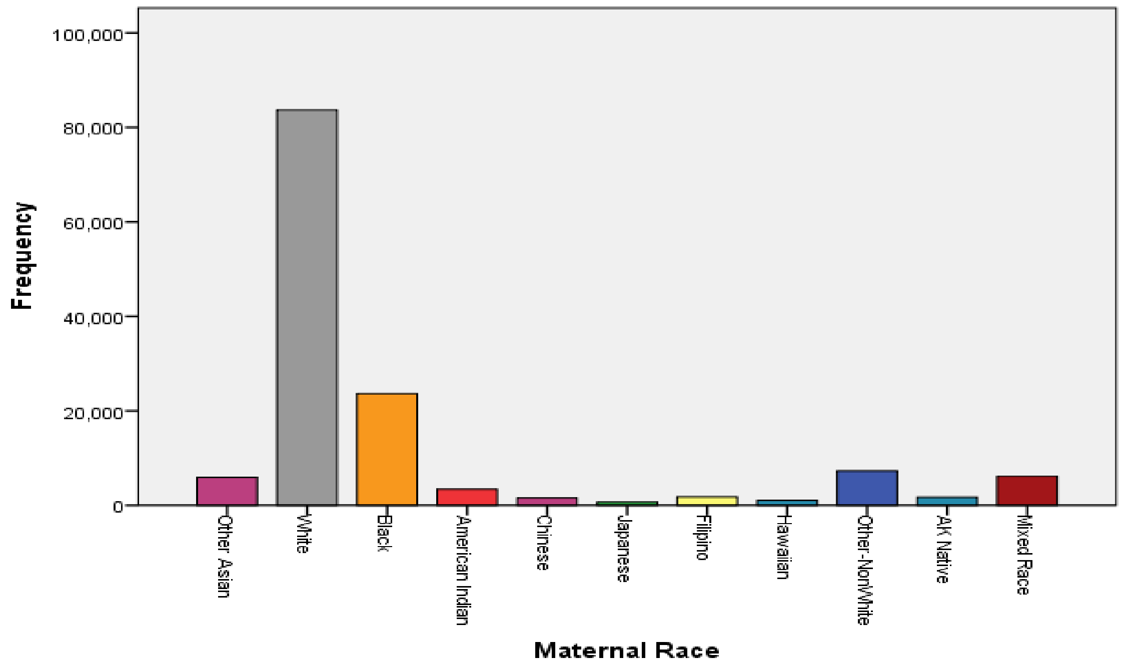

Figure 5. Maternal race distribution

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Below Table 9 and Figure 6 display of the household income for selected participants. Of the 141,859 women who were surveyed, 129,603 provided information regarding their income. Close to 76% of women are at the federal poverty level. About 3% of the women are at the low-income level. About 21% of the women are at the middle-income level.

Table 9

Household income

		Frequency	Percent	Valid percent	Cumulative percent
	Federal poverty level	97907	69.0	75.5	75.5
	Low income	4144	2.9	3.2	78.7
	Middle income	27552	19.4	21.3	100.0
	Total	129603	91.4	100.0	
Information not Provided		12256	8.6		
Total		141859	100.0		

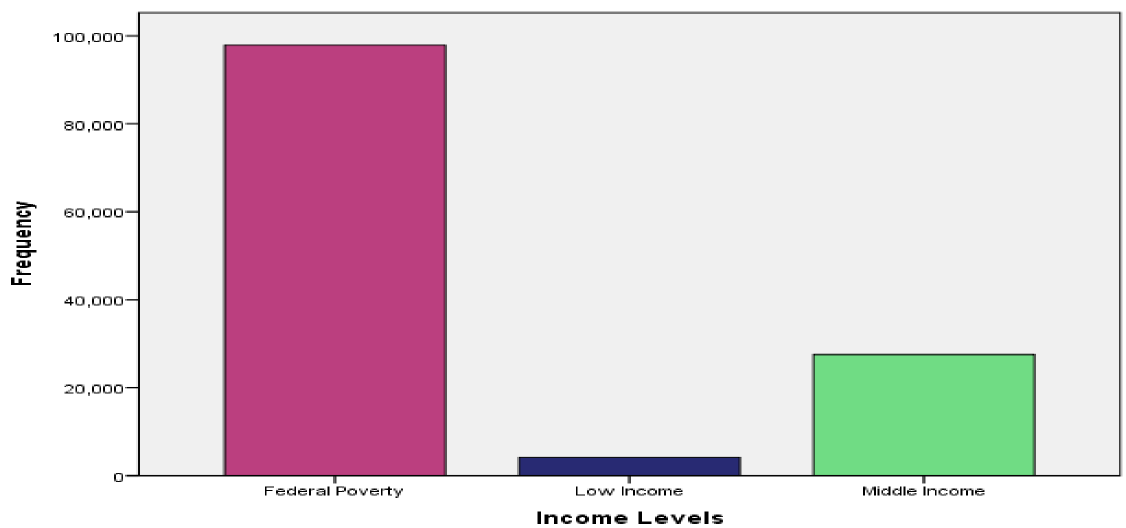

Figure 6. Household income distribution

Table 10 and Figure 7 display the maternal BMI distribution and preterm cases among the survey participants. The total number of participants surveyed was 80,601. Of 80,601 women surveyed, 53,556 (66.4%) women are of normal weight, 14,646 (18.2%) are moderately obese, 7,048 (8.7%) are severely obese, and 5,351 (6.6%) are very severely obese. Also, of 80,601 women, 3,795 in total had preterm birth while 76,806 had no preterm birth cases. Of those that had preterm cases, 2,288 (60.3%) were from normal weight, 799 (21.1%) were from moderate obese women, 401 (10.6%) were from severely obese women, and 307 (8.1%) were from very severely obese women. Of 76,806 who did not have preterm birth, 51,268 (66.7%) were from women of normal weight, 13,847 (18.0%) were from moderate obese women, 6,647 (8.7%) were from severely obese women, and 5,044 6.6%) were from very severely obese women.

Table 10

Maternal BMI distribution, proportion of women with preterm or no preterm

Preterm Level * Maternal BMI cross tabulation							
				Maternal BMI			
Normal weight %	Moderate obesity count	Moderate obese %	Severe obese count	Severe obese %	Very severe obese count	Very severe obese %	Total
60.3	799	21.1	401	10.6	307	8.1	3795
66.7	13847	18.0	6647	8.7	5044	6.6	76806
66.4	14646	18.2	7048	8.7	5351	6.6	80601

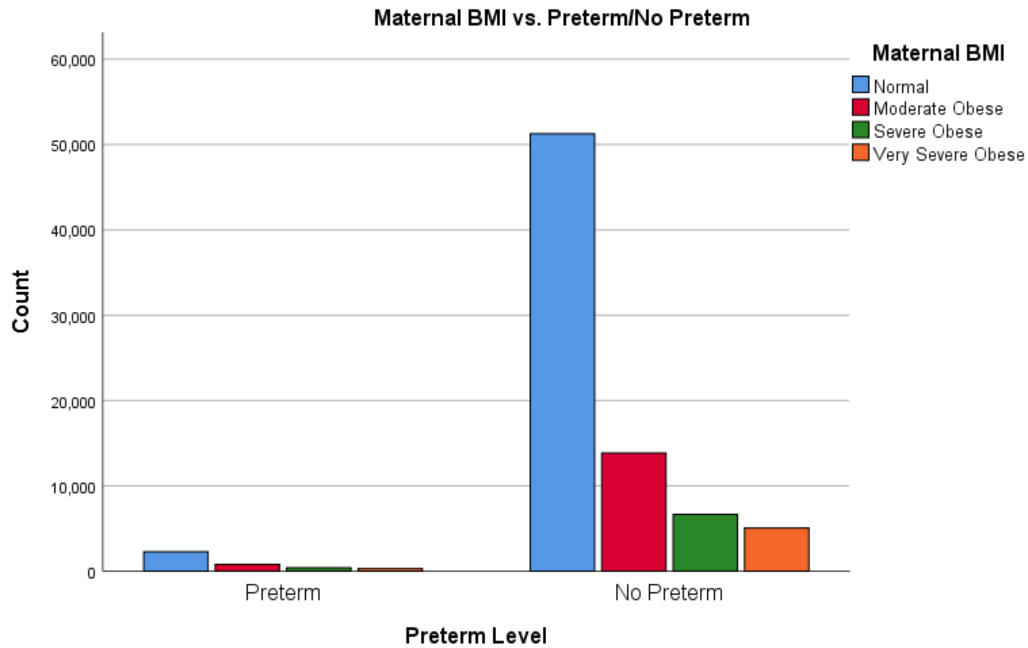

Figure 7. Maternal BMI distribution

Table 11 and Figure 8 represent the neonate birthweight distribution. The total number of women surveyed for this question was 141,859 participants. Approximately 24% neonates were born with low birthweight. On the other hand, 75% of neonates were born with a normal birthweight or high birthweight.

Table 11

Neonate birthweight distribution

		Frequency	Percent	Valid percent	Cumulative percent
Unknown birthweight		313	.2	.2	.2
grams	Low birthweight 0-2500grams	34623	24.4	24.4	24.6
	Neonate birthweight >2500grams	106923	75.4	75.4	100.0
	Total	141859	100.0	100.0	

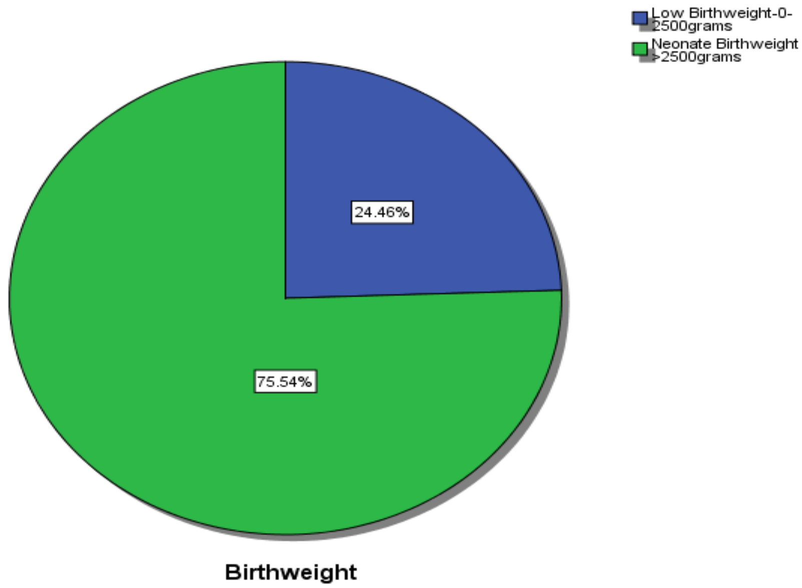

Figure 8. Neonate birthweight distribution

The preterm distribution is shown in Table 12 and Figure 9. The total number of women surveyed for this question was 141,859. Of those surveyed, 120,290 women in total responded. Of those who responded, approximately 5% of the women had preterm birth outcomes while 95% of the women had no preterm birth.

Table 12

Preterm level distribution

		Frequency	Percent	Valid percent	Cumulative percent
	Preterm	5722	4.0	4.8	4.8
	No preterm	114568	80.8	95.2	100.0
	Total	120290	84.8	100.0	
Information unknown		21569	15.2		
Total		141859	100.0		

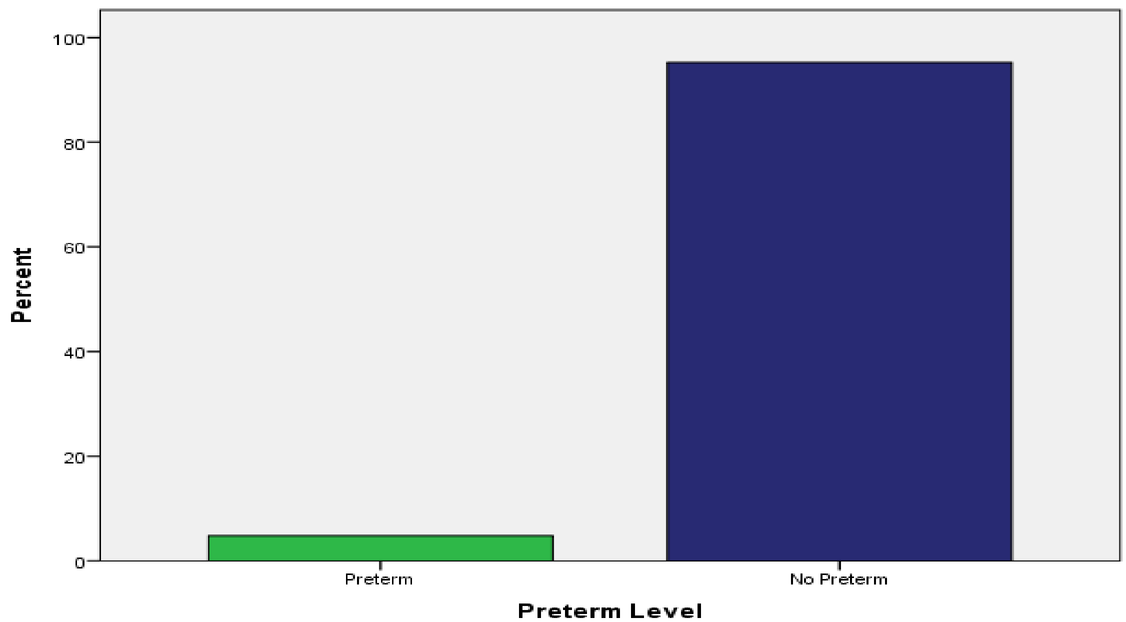

Figure 9. Preterm level distribution

Inferential Analysis

The RQs were addressed inferentially in this current study:

RQ1

RQ1: Is obesity status (moderate, severe, and very severe) among women ages 18-39 years associated with a change in the prevalence of preterm birth when compared to women with a normal body weight?

Results Unadjusted for Potential Confounding Variables

Moderate obesity versus normal weight. In unadjusted results, moderately obese women compared to normal weight women had a 23% significantly lower odds of preterm birth (*β = -0.257, W(1) = 37.077, OR = 0.773, p*** < 0.001, 95% CI [0.712, 0.840])*, see Table 13. Based on the information presented in Table 13, moderate obese status was a predictor of preterm birth. Therefore, preterm birth outcomes among women with moderate obese status compared to women with normal body weight was statistically significant (*p*** < 0.001)*.

Severe obesity versus normal weight. Also, using women with normal weight as the reference group, the reported preterm outcome between women of severe obese status compared to women with normal weight is described inferentially as follows; $\beta = -0.301$, $W(1) = 29.302$, $OR = 0.740$, $p^{***} < 0.001$, *95% CI [0.663, 0.825]*, see Table 13. Based on the information presented in Table 11, severe obese status predicted preterm birth in unadjusted models. As a result, preterm birth outcomes between women with severe obese status compared to those with normal body weight was statistically significant ($p^{***} < 0.001$). However, women with severe obese status had similar preterm birth outcome risk ($OR = 0.740$) compared to women with normal weight.

Very severe obesity versus normal weight. Similarly, in the unadjusted model illustrated in Table 13, using women with normal weight as the reference group, the reported preterm outcome between women of very severe obese status compared to women with normal body weight is described inferentially as follows; $\beta = -0.310$, $W(1) = 24.609$, $OR = 0.733$, $p < 0.001$, *95% CI [0.649, 0.829]*. Based on the information presented in Table 13, very severe obese status predicted preterm birth. As a result, preterm birth outcomes among women with very severe obese status were statistically significant compared to women with normal weight ($p < 0.001$).

Prevalence of preterm birth among obese categories combined (moderate, severe, very severe). The total number of women who were (moderate, severe and very severe obese) at risk that were included in this inferential analysis was 27,045. The total number of cases of obese women who had preterm births was 1,507. Therefore, the prevalence of preterm birth among women of obese status (moderate, severe, very severe) was calculated as follows:

Prevalence = Total number of cases (preterm birth)/ Total number of population at risk (moderate, severe, very severe)

* Rescaling of the prevalence per 1000 women*

Prevalence = Total number of cases (preterm birth)/ Total number of population at risk (moderate, severe, very severe)*1,000

Total number of cases of Preterm birth = 1,507 (See Table10)

Total number of population at risk (moderate, severe, very severe obese) = (14,646+7,048+5,351) (See Table 10)

Prevalence of Preterm Birth = 1,507/ 27,045 = 0.0557

The prevalence per 1,000 women

Prevalence of Preterm Birth = (0.0557)*1000

Prevalence of Preterm Birth =55.7 or 56

Among women population included in this study who provided a complete response for their BMI and preterm statuses during an infant delivery at the health facility, the prevalence of preterm births among obese women (moderate, severe, and very severe) was 56 preterm births per 1000 live births.

Prevalence of preterm birth among normal weight. The total number of women with normal BMI at risk that were included in this inferential analysis was 55,556. The total number of cases of preterm births among normal weight women was

2,288. Therefore, the prevalence of preterm birth among of normal weight status was calculated as follows:

Prevalence = Total number of cases (preterm birth)/ Total number of population at risk (Women of Normal Weight) *1000

Total Number of Cases of Preterm Birth = 2,288 (See Table 10)

Total number of population at risk (normal body weight, 53,556) (See Table 10)

Prevalence of Preterm Birth = 2,288/53,556 = 0.0427

Rescaling of the prevalence per 1000 women

(0.0427) *1000 = 42.7 or 43

Based on this estimate, the prevalence of preterm births among normal body weight was 43 preterm births per 1000 live births

Table 13

Binary logistics regression of women BMI and preterm birth

		B	S.E.	Wald	df	Sig.	Exp(B) OR	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Normal weight			68.276	3	.000			
	Moderate obese	-.257	.042	37.077	1	.000	.773	.712	.840
	Severe obese	-.301	.056	29.302	1	.000	.740	.663	.825
	Very severe obese	-.310	.063	24.609	1	.000	.733	.649	.829
	Constant	3.109	.021	21176.018	1	.000	22.407		

a. Variable(s) entered on step 1: Maternal BMI.

Shown in Table 14 is the classification table for the predicted effect of the obese statuses (moderate, severe, and very severe obese) on preterm birth outcomes. The predictive ‘cut value’ was set at 0.500, indicating that the probability of preterm birth outcomes for the ‘preterm’ cases is greater than 0.500. Included in Table 14 are percentage accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. The percentage accuracy in classification reflected the cases that are correctly classified as ‘no preterm’ when women with obese status were added in the model. The sensitivity is the percentage of cases that had ‘preterm’. The specificity is indicated as the percentage of cases that did not have preterm birth (no preterm). The positive and negative predictive values are the percentages of correctly predicted cases for preterm or no preterm compared to the total number of cases.

Table 14

Preterm birth outcome level classification table

		Predicted		
		Preterm level		
Observed		Preterm	No preterm	Percentage correct
Preterm outcome	Preterm	0	3795	.0
	No preterm	0	76806	100.0
Overall percentage				95.3

a. The cut value is .500

Table 15 shows the model summary for women with obese status predicted preterm birth. The Cox and Snell R square model suggested that only 0.1% of the preterm birth could be explained by the obese status without accounting for any covariates or confounders. The Nagelkerke R square model, however, suggested that only 0.3% of preterm birth outcomes could be explained by obese status.

Table 15

Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	30535.336[a]	.001	.003

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

RQ1 Analysis Including Age

Using women with maternal age between 18-19 years as the reference group, reported preterm outcome among women within the ages of 20-24 years were described inferentially as follows; $\beta = -0.992$, $W(1) = 48.277$, $OR = 0.371$, $p^{***} < 0.001$, *95% CI [0.280, 0.490]*, see Table 14. Based on this result, ages between 20-24 years predicted preterm birth. Therefore, preterm birth cases among women between 20-24 years were statistically significant ($p^{***} < 0.001$) compared to women between ages of 18-19 years. However, women between ages 20-24 years had lower risk of preterm birth outcomes compared to women between the ages of 18-19 years.

Women ages 25-29 years were described inferentially as follows; $\beta = -1.267$, $W(1) = 81.385$, $OR = .282$, $p^{***} < 0.001$, *95% CI [0.214, 0.371]*, see Table 16. Based on this result, women ages 25-29 years predicted preterm birth. As a result, preterm birth among women ages 25-29 years were statistically significant ($p^{***} < 0.001$) compared to those ages 18-19 years However, women ages 25-29 years had lower risk of preterm birth outcomes compared to those ages 18-19 years.

Shown in Table 16, preterm birth outcome among women ages 30-34 years was represented as follows; $\beta = -1.380$, $W(1) = 96.659$, $OR = .252$, $p^{***} < 0.001$, *95% CI [0.191, 0.331]*. Based on this result, women ages 30-34 years predicted preterm birth.

Preterm birth among women between 30-34 years were statistically significant ($p^{***} < 0.001$) compared to women ages 18-19 years. However, women ages 30-34 years had lower risk (OR = 0.252) of preterm birth outcomes compared to women ages18-19 years.

Also shown in Table 16, preterm outcome among women ages 35-39 years were represented as follows; $\beta = -1.552$, $W(1) = 117.403$, $OR = .212$, $p^{***} < 0.001$, *95% CI [0.160, 0.281]*. Hence, women ages between 35-39 years were a predictor of preterm birth. Preterm birth among women ages 35-39 years were statistically significant ($p^{***} < 0.001$) compared to women of who were between ages of 18-19 years. However, women ages 35-39 years had lower risk ($OR = 0.212$) of preterm birth outcomes compared to women between the ages of 18-19 years.

Below in Table 16, the confounder age groups (18-39) were included in the analysis. Using women with normal weight as the reference group, the reported preterm outcome among women of moderate obese status was as follows; $\beta = -0.221$, $W(1) = 26.196$, $OR = 0.802$, $p^{***} < 0.001$, *95% CI [0.737, 0.873*. Based on this result, moderate obese status was a predictor of preterm birth when age is accounted for. Hence, preterm birth among women with moderate obese status was statistically significant ($p^{***} < 0.001$) when compared to women of normal weight. However, women with moderate obese status had slightly lower or similar risk ($OR = 0.802$) of preterm birth outcomes compared to women of normal weight.

In Table 16, preterm outcome among women of severe obese status when age was accounted for is as follows; $\beta = -0.272$, $W(1) = 23.059$, $OR = 0.761$, $p^{***} < 0.001$, *95% CI [0.681, 0.851]*. Here, severe obese status predicted preterm birth. Preterm birth among women with severe obese status was statistically significant (*p*** < 0.001)* when compared to women of normal weight. However, women with severe obese status had lower risk (*OR = 0.272*) of preterm birth outcomes compared to women of normal weight.

Among women of very severe obese status, the preterm birth is represented as follows; *β = -0.256, W(1) = 16.198, OR = 0.774, p*** < 0.001, 95% CI [0.683, 0.877*]. In Table 16, very severe obese status predicted preterm birth. Therefore, preterm birth among women with very severe obese status was statistically significant (*p*** < 0.001)* when compared to women of normal weight. However, women with very severe obese status had lower risk (*OR = 0.774*) of preterm birth outcomes compared to women of normal weight.

Table 16

Women obesity level and maternal age and preterm birth variables in the equation

		B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Maternal age 18-19			193.388	4	.000			
	Maternal age 20-24	-.992	.143	48.277	1	.000	.371	.280	.490
	Maternal age 25-29	-1.267	.140	81.385	1	.000	.282	.214	.371
	Maternal age 30-34	-1.380	.140	96.659	1	.000	.252	.191	.331
	Maternal age 35-39	-1.552	.143	117.403	1	.000	.212	.160	.281
	Normal BMI			49.096	3	.000			
	Moderate obese	-.221	.043	26.196	1	.000	.802	.737	.873
	Severe obese	-.272	.057	23.059	1	.000	.761	.681	.851
	Very severe obese	-.256	.064	16.198	1	.000	.774	.683	.877
	Constant	4.334	.137	995.259	1	.000	76.233		

a. Variable(s) entered on step 1: Maternal Age, Maternal BMI.

The model summary on the effects of maternal age and maternal obese levels on preterm birth is shown in Table 17. Based on the Cox and Snell R square model, only 0.4% of the preterm birth could be explained by maternal age and obese level, when the maternal age confounder is accounted for. On the other hand, the Nagelkerke R square model suggested that only 1.2% of preterm birth outcomes could be explained by maternal age and obesity level.

Table 17

Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	29071.918[a]	.004	.012

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

RQ1 Including Age, Income, Education Level, Marital Status, Race, and Ethnicity

Shown in Table 18 is the classification table for the predicted effect of obese status (moderate, severe, and very severe) on preterm birth outcomes. In this analysis, the predictive ‘cut value’ was set at 0.500. Percentage accuracy, sensitivity, specificity, positive predictive value, and negative predictive value were included in Table 18. The percentage accuracy represents the cases that are correctly classified as ‘preterm’ when maternal age was included in the model. The sensitivity is the percentage of cases that had ‘no preterm’. Specificity is presented as the percentage of cases that did not have preterm birth (no preterm). Positive and negative predictive values are the percentages of correctly predicted cases of preterm or no preterm compared to the total number of cases.

Table 18

Classification table on neonate preterm birth outcomes when looking at confounders

			Predicted		
			Preterm Level		
	Observed		Preterm	No preterm	Percentage correct
Step 1	Preterm outcome	Preterm	0	2100	.0
		No preterm	0	38661	100.0
	Overall percentage				94.8

a. The cut value is .500

Preterm births among women who are moderate, severe and very severe women of the fully adjusted model shown in Table 19 are as follows; moderate *β =-0.37, W(1) = .420, OR = .964, p = .517, 95% CI [.862, 1.077];* severe *β =.003, W(1) = .001, OR = 1.003, p = .970, 95% CI [.867, 1.160]; very severe β =-0.48, W(1) = .341, OR = 1.049, p = .559, 95% CI [.894, 1.231]* respectively and showed no significance. When women with elementary/junior high school status were used as the reference group, the preterm birth outcome among women with some high school education is shown in Table 19 as follows: *β =-0.518, W(1) = 11.634, OR = 0.596, p = 0.001, 95% CI [.443, .802]*. Women with some high school education had a statistically significant p value for preterm birth. Women who completed college or attained higher also had a statistically significant p-value for preterm births*; β = 0.611, W(1) = 14.377, OR = 1.843, p*** < 0.001, 95% CI* [*1.343, 2.527*]. The rest of the education levels were not statistically significant. Meaning women with higher education have 85% higher risk of preterm birth when compared with women who have an elementary/ junior high education level.

Using federal poverty level income as the reference group, the group middle income showed that women who were identified as having a middle-income status had a statistically significant p-value for preterm birth. Table 19 below shows *β = 0.318W (1) = 26.960, OR = 1.374, p*** < 0.001, 95% CI [1.219, 1.549]*. The low-income category was not identified as having a statistically significant p-value. Based on this, women at middle-income level are 1.37 times more likely to have a preterm birth or have 37% higher odds of preterm birth than women at Federal Poverty Level.

Using age group 18-19 as a reference, age groups 20-24, 25-29, 30-34 and 35-39 were statistically significant. Below, Table 19 shows as follows, Age group 20-24; *β =-1.365 W(1) = 51.307, OR = .255, p*** < 0.001, 95% CI [.176, .371]*. Age group 25-29; *β =-1.914, W(1) = 101.800 OR = .148, p*** < 0.001, 95% CI [.102, .214]*. Age group 30-34; *β =-2.220, W(1) = 134.672, OR = .109 p*** < 0.001, 95% CI [.075, 2..158]*. Age group 35-39; *β =-2.444, W(1) = 154.910, OR = .087, p*** < 0.001, 95% CI [.059, .128]*. Women between the ages of 20-24 years had 75% lower odds of preterm birth when compared to women between the ages of 18-19 years. Women between the ages of 25-29, 30-34, and 35-39 years had 85%, 89%, and 91% lower odds of preterm births respectively when compared with women ages 18-19 years..

Accounting for race, when Other-Asian was used as the reference group, the preterm birth outcome for Blacks is as follows; *β = -0.678, W(1) = 15.089, OR = .508 p***<0.001, 95% CI [.361, .715]*, see Table 19. Blacks are therefore a predictor of preterm birth outcomes and had 49% higher odds of preterm births. The preterm birth outcome for American Indian is as follows; *β = -0.516, W (1) = 6.613, OR = 0.597,* *p=0.010, 95% CI [0.403, 0.885]*, see Table 19. This indicates that women who identified themselves as American Indians were predictors of preterm birth. The racial group of White was also a predictor of preterm birth as shown in Table 19; *β = -0.520, W(1) = 9.420, OR = 0.595, p=.002, 95% CI [0.427,0.829]*. The AK Native racial group was also a predictor of preterm birth; *β = -0.547, W(1) = 7.698, OR =.579 p=0.006, 95% CI [.393, .852]*. Other race groups such as Chinese, Japanese, Filipino, and Hawaiian were not statistically significant in predicting preterm birth outcomes. Ethnicity and marital status were also not statistically significant in predicting preterm birth outcomes. However, in the presence of the stated confounders (age, education, marital status, race, and ethnicity) none of the obese status predicted preterm birth.

Table 19

Confounder variables and preterm birth

				Wald				95% C.I. for EXP(B)	
		B	S.E.	df	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Elementary/ Junior High School			146.825	4	.000			
	Some High School	-.518	.152	11.634	1	.001	.596	.443	.802
	Completed High School	-.240	.148	2.629	1	.105	.787	.589	1.051
	Some College	-.045	.148	.094	1	.760	.956	.714	1.278
	Completed College	.611	.161	14.377	1	.000	1.843	1.343	2.527
	Federal Poverty Level			27.932	2	.000			
	Low Income	.218	.102	4.575	1	.032	1.244	1.018	1.519
	Middle Income	.318	.061	26.960	1	.000	1.374	1.219	1.549

							95% C.I. for	
			Wald				EXP(B)	
	B	S.E.	df	Df	Sig	Exp(B)	Lower	Upper
18-19 Yrs. Age			323.500	4	.000			
20-24 Yrs. Age	-1.365	.191	51.307	1	.000	.255	.176	.371
25-29 Yrs. Age	-1.914	.190	101.800	1	.000	.148	.102	.214
30-34 Yrs. Age	-2.220	.191	134.672	1	.000	.109	.075	.158
35-39 Yrs. Age	-2.444	.196	154.910	1	.000	.087	.059	.128
Other -Asian			35.714	9	.000			
White	-.520	.169	9.420	1	.002	.595	.427	.829
Black	-.678	.174	15.089	1	.000	.508	.361	.715
American Indian	-.516	.201	6.613	1	.010	.597	.403	.885
Chinese	.818	.445	3.385	1	.066	2.266	.948	5.416
Japanese	17.685	5468.667	.000	1	.997	47895016.180	.000	.
Filipino	.072	.447	.026		.873	1.074	.447	2.581
Hawaiian	17.627	10951.405	.000	1	.999	45200190.680	.000	.
Other-Non-White	-.266	.207	1.652	1	.199	.766	.510	1.150
AK Native	-.547	.197	7.698	1	.006	.579	.393	.852
Normal Weight			.986	3	.805			
Moderate Obese	-.037	.057	.420	1	.517	.964	.862	1.077
Severe Obese	.003	.074	.001	1	.970	1.003	.867	1.160
Very Severe Obese	.048	.082	.341	1	.559	1.049	.894	1.231
Married			.842	2	.656			
Not Married	.048	.053	.826	1	.363	1.050	.946	1.165

(table continues)

	B	S.E.	Wald df	df	Sig	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Unknown Marital Status	-.049	.610	.007	1	.935	.952	.288	3.147
Hispanic			.047	2	.977			
Non-Hispanic	.013	.076	.031	1	.861	1.014	.873	1.177
Missing	.045	.330	.019	1	.891	1.046	.548	1.997
Constant	5.202	.287	329.372	1	.000	181.612		

Variable(s) entered on step 1: education, income, age, race, BMI, marital status, Hispanic ethnicity.
The sample size used to generate the table was 141,859 women

(table continues)

Table 20 represents the model summary when age, income, education level, marital status, race, and ethnicity are accounted for. The Cox and Snell R square model showed that only 1.5% of the preterm birth could be explained by age, income, education level, marital status, race, and ethnicity. The Nagelkerke R square model, however, suggested that only 4.5% of preterm birth outcomes could be explained by age, income, education level, marital status, race, and ethnicity.

Table 20

Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	15927.017[a]	.015	.045

a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

RQ2

What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese?

Results Unadjusted for Potential Confounding Variables

Below in Table 21 is the classification table for the predicted effect of moderate obese and very severe obese status on neonate birthweight outcomes. The predictive ‘cut value’ was 0.500, indicating that the probability of neonate low birthweight outcomes for the ‘low birthweight ‘cases is greater than 0.500. Included in Table 21 are percentage accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. Percentage accuracy reflected the cases that are correctly classified in ‘neonate birthweight for women with moderate obese compared to women with very severe obese status. Sensitivity is the percentage of cases that had ‘low birthweight’ (0-2500 grams). Specificity represented the percentage of cases that did not have low birthweight (neonate birthweight >2500). The positive and negative predictive values are the percentages of correctly predicted cases for low neonate birthweight (0-2500 grams) or neonate with low birthweight (>2500 grams) compared to the total number of cases.

Table 21

Classification table for neonate birthweight

	Observed		Predicted		
			Birthweight		
			Low birthweight 0-2500grams	Neonate birthweight >2500grams	Percentage correct
Step 1	Birthweight	Low birthweight [0-2500grams]	0	23202	.0
		Neonate birthweight [>2500grams]	0	71745	100.0
	Overall percentage				75.6

a. The cut value is .500

In unadjusted results, when women with very severe obese status were used as the reference group, women of moderate obese status had a 12% significantly higher odds of neonate low birth weight (*β = -115, W(1) = 11.389, OR = 1.122, p = 0.001, 95% CI [1.049, 1.199])*, see Table 22.

Table 22

Variables in the equation for maternal BMI and neonate birthweight

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Maternal with Very Severe Obese			17.462	3	.001			
	Maternal with Normal BMI	.112	.030	13.519	1	.000	1.118	1.053	1.187
	Maternal with Moderate Obese	.115	.034	11.389	1	.001	1.122	1.049	1.199
	Maternal with Severe Obese	.054	.038	1.985	1	.159	1.056	.979	1.138
	Constant	1.029	.029	1269.023	1	.000	2.799		

a. Variable(s) entered on step 1: Maternal BMI.

Table 23 below displays the model summary for women with moderate obese prediction of neonate low birthweight against women with very severe obese status. The Cox and Snell R square model showed that none (0%) of the neonate low birthweight could not be explained by moderate obese status. Similarly, the Nagelkerke R square model suggested that none of the neonate low birthweight outcomes could be explained.

Table 23

Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	105575.704[a]	.000	.000

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

RQ2 and RQ3 Adjusted by Age, Income, Education Level, Marital Status, Race, and Ethnicity

RQ2. The neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese for the adjusted model shown in Table 25, are described as follows: moderate β =-0.91, W(1) = 3.982, OR = 1.095, p = .046, 95% CI [1.002, 1.198]. This suggests that women, who were moderately obese, had a 10% low odd of low neonate birthweight when compared to those of women who are very severely obese.

Shown in Table 24 is the classification table for the predicted effect of age, marital status, education, income, race and ethnicity on neonate low birthweight outcomes. The predictive ‘cut value’ was set at 0.500, which means that the probability of neonate low birthweight outcomes for the ‘neonate low birth weight’ cases was greater than 0.500. Included in Table 24 are percentage accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. Percentage accuracy in classification reflected the cases that were correctly classified ‘neonate birthweight when age, education, income, marital status, race and ethnicity were added in the model. Sensitivity is the percentage of cases that had ‘low birthweight’ (0-2500 grams). Specificity represented the percentage of cases that did not have low neonate birthweight (> 2500 grams). Positive and negative predictive values were the percentages of correctly predicted cases for low neonate birthweight (0-2500 grams) or neonate with birthweight > 2500 grams compared to the total number of cases.

Table 24

Classification table for neonate birthweight accounting for confounders

	Observed		Predicted Birthweight: Low Birthweight 0-2500grams	Predicted Birthweight: Neonate Birthweight >2500grams	Percentage Correct
Step 1	Birthweight	Low Birthweight-0-2500grams	0	11436	.0
		Neonate Birthweight >2500grams	0	34500	100.0
	Overall Percentage				75.1

a. The cut value is .500

All of the stated confounders (education level, income level, age group, race, marital status, and ethnicity) were included in the model. In the presence of obese status (moderate, severe and very severe) for the reported neonate low birthweight outcome only women with moderate obese status shown as follows; *β =.091, W(1) = 13.982, OR = 1.095, p = .046 95% CI [1.002, 1.198]* had statistically significant p-value, see Table 25. Women who were moderately obese were 1.11 times more likely to have neonate low birth weight or have 11% higher odds of neonate low birthweight, compared to women who were very severely obese. Thus, moderate obese status was associated with low neonate birthweight. Severe and very severe obese status did not associate with low neonatal birthweight.

When moderate, severe and very severe women were used in the adjusted model and with elementary/junior high school, level as a reference group, the reported neonate low birthweight outcome among women with some high school, high school graduate, some college, college graduate showed no statistical significance p-values and thus are not predictors of low neonate birthweight. Therefore, education level is not risk factor among women with cases of low neonate birthweight.

When women with federal poverty level used as the reference group, the reported neonate low birthweight outcome among women middle income is described as follows; $\beta = 0.230, W(1) = 60.125, OR = 1.259, p^{***} < 0.001$, *95% CI [1.187, 1.334]*, see Table 25. Based on this result, women with middle-income status is a predictor of neonate low birthweight. Therefore, the cases of neonate low birthweight among women with middle-income status are statistically significant ($p^{***} < 0.001$) and with 1.26 times more likely to have low birthweight or have a 26% higher odds of low birthweight compared to women within the federal poverty level. On the other hand, cases of neonate low birthweight among women with low-income level were not statistically significant and not a predictor of neonate low birthweight.

When maternal age group (18-19 years old) was used as the reference group, the reported neonate low birthweight outcome among women ages 30-34 years old status is represented as follows; $\beta = -.167$ $W(1) = 10.523, OR = .847, p^{***} = 0.001$, *95% CI [.765, .936]*, see Table 25. Thus, age group 30-34 years old is a predictor of neonate low birthweight and had a 15% lower odds of neonate low birthweight. Hence, the cases of neonate low birthweight among women ages 30-34 are statistically significant ($p^{***}=0.001$) compared to women ages 18-19 years old. Similarly, the reported neonate low birthweight outcome among women ages 35-39 years old was represented as; β =-

*.339 W(1) = 34.718, OR = .712, p***<0.001, 95% CI [.636, .797*], and had a 29% low odds of neonate low birthweight, which indicated that women ages 35-39 years old is a predictor of neonate low birthweight. Thus, women ages 35-39 years old are at risk of neonate low birthweight outcomes compared to women ages 18-19 years old. Meanwhile, the reported neonate low birthweight outcome among women of age group 20-24 and 25-29 years old are not predictors of neonate low birthweight. Therefore, the cases of neonate low birthweight among women of those age groups are not statistically significant.

When women of Other-Asian race were use used as the reference group, the reported neonate low birthweight outcome among White women is described as follows; *β =-.296W(1) = 19.627, OR = .724, p***<0.001, 95% CI [.653, .848]*, see Table 25. Hence, being White is a predictor of neonate low birthweight. Thus, cases of neonate low birthweight among White women are statistically significant (*p***<0.001)* compared to women of other-Asian race. Based on this information White women are slightly at lower risk (*OR* = .724) of neonate low birthweight outcomes compared to women of other-Asian race. Also, the reported neonate low birthweight outcome among American Indian women is as follows; *β =.572 W(1) = 33.715, OR = 1.755, p***<0.001, 95% CI [1.452, 2.122]*, see Table 25. Therefore, American Indian women are 1.76 times more likely to have neonate low birthweight or have a 76% high odd of neonate low birthweight. The cases neonate low birthweight among American Indian women are statistically significant (*p***<0.001)* compared to women of other-Asian race. Thus, American Indian women are at higher risk (*OR = 1.755*) of neonate low birthweight outcomes compared to women of other-Asian race. On the other hand, neonate birthweight among women who identified themselves as Black, Chinese, Japanese, Filipino, Hawaiian, Other Non-White, AK Native, were not statistically significant compared to women of other-Asian race.

When marital status was used as the reference group, the reported neonate birthweight outcome among women who are not married was represented inferentially as follows: *β =-.243, W(1) = 30.261, OR = .865, p*** < 0.001, 95% CI [.396, 1.553]*, see Table 25. It shows that women who are not married are a predictor of low neonate birthweight. Based on this findings, unmarried women had a 13% lower odds of neonate low birthweight and was also statistically significant (p***<0.001) when compared to women who are married.

When Hispanic ethnicity was used as the reference group in Table 25 women who reported that they were of Non-Hispanic ethnicity were represented inferentially as follows: *β =.388, W(1) = 95.931, OR = 1.473, p*** < 0.001, 95% CI [1.363, 1.592]*. Indicating that Non-Hispanic ethnicity is a predictor of neonate low birthweight and is statistically significant p***<0.0001 when compared to Hispanics.

Table 25

Confounder variables used in the equation on neonate low birthweight

								95% C.I. for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Elementary/Junior High school			82.381	4	.000			
	Some high school	-.255	.081	9.909	1	.002	.775	.661	.908
	High school graduate	-.198	.078	6.506	1	.011	.820	.704	.955
	Some college	-.059	.078	.575	1	.448	.942	.809	1.098
	College graduate/ higher	.087	.082	1.146	1	.284	1.091	.930	1.281

Federal Poverty Level			61.028	2	.000			
Low income	.139	.050	7.716	1	.005	1.149	1.042	1.267
Middle income	.230	.030	60.125	1	.000	1.259	1.187	1.334
18-19 yrs.			61.703	4	.000			
20-24 yrs.	-.036	.048	.585	1	.444	.964	.878	1.059
25-29 yrs.	-.092	.049	3.543	1	.060	.912	.829	1.004
30-34 yrs.	-.167	.051	10.523	1	.001	.847	.765	.936
35-39 yrs.	-.339	.058	34.718	1	.000	.712	.636	.797
Other Asian			249.074	9	.000			
White	-.296	.067	19.627	1	.000	.744	.653	.848
Black	-.108	.071	2.324	1	.127	.898	.782	1.031
American Indian	.562	.097	33.715	1	.000	1.755	1.452	2.122
Chinese	.468	.150	9.782	1	.002	1.597	1.191	2.140
Japanese	.067	.342	.038	1	.845	1.069	.547	2.090
Filipino	.047	.172	.073	1	.787	1.048	.747	1.469
Hawaiian	-.298	.590	.255	1	.613	.742	.233	2.360
Other -NonWhite	-.146	.089	2.686	1	.101	.864	.726	1.029
AK Native	.146	.086	2.884	1	.089	1.158	.978	1.371
Very severe obese			**13.883**	**3**	**.003**			
Normal weight	-.012	.041	.085	1	.770	.988	.911	1.071
Moderate obese	**.091**	**.046**	**3.982**	**1**	**.046**	**1.095**	**1.002**	**1.198**
Severe obese	**-.018**	**.051**	**.121**	**1**	**.728**	**.982**	**.889**	**1.086**
Married			30.467	2	.000			
Not married	-.145	.026	30.261	1	.000	.865	.821	.911
Unknown marital Status	-.243	.349	.487	1	.485	.784	.396	1.553
Hispanic			95.931	2	.000			
Non-Hispanic	.388	.040	95.861	1	.000	1.473	1.363	1.592
Missing	.049	.169	.084	1	.771	1.050	.754	1.463
Constant	1.413	.109	168.324	1	.000	4.106		

a. Variable(s) entered on step 1: Education, Income, New, Maternal Race, Maternal BMI, Marital Status, Hispanic Ethnicity

b. The sample size used to generate the table 141,859 women

The model summary for neonate birthweight comparison between moderate and very severe obese status after accounting for age, marital status, education, income, race and ethnicity is displayed in Table 26. The Cox and Snell R square model indicated that only 1.5% of the neonate low birthweight could be explained by moderate obese status after accounting for age, marital status, education, income, race, and ethnicity. The Nagelkerke R square model also suggested that 2.2% of neonate low birthweight outcomes could be explained moderate obese status after accounting for age, marital status, education, income, race, and ethnicity.

Table 26

Model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	50885.462[a]	.015	.022

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

RQ3.

What is the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese? According to the adjusted model displayed shown in Table 25 above, the neonate birthweight significance estimate of women who are severely obese compared to those who were very severely obese are as follows: β *=-.018, W(1) = .121, OR = .982, p = .728, 95% CI [.889, 1.086]*.

Below Table 27 is the classification table for the comparative predicted effect between severely obese and very severe obese status on neonate birth outcomes. The predictive ‘cut value’ was set at 0.500, indicating that the probability of neonate low birthweight outcomes was greater than 0.500. Included in Table 27 are percentage accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. Percentage accuracy in classification reflected the cases that are correctly classified as ‘neonate birthweight among women who are severely obese. Sensitivity is the percentage of cases that had ‘low neonate birthweight’. Specificity is the percentage of cases that did not have low neonate birthweight. Positive and negative predictive values are the percentages of correctly predicted cases for neonate low birthweight or neonate without low birthweight compared to the total number of cases.

Table 27

Neonate birthweight classification table (Unadjusted Model)

	Observed		Predicted: Birthweight: Low birthweight 0-2500grams	Predicted: Birthweight: Neonate birthweight >2500grams	Predicted: Percentage correct
Step 1	Birthweight	Low birthweight [0-2500 grams]	0	23202	.0
		Neonate birthweight [>2500 grams]	0	71745	100.0
	Overall percentage				75.6

a. The cut value is .500

When women with very severe obese status was used as the reference group, the reported neonate low birthweight outcome among women of severe obese status was inferentially represented as follows; *β = 0.054, W(1) = 1.985, OR = 1.056, p = 0.159, 95% CI [0.979, 1.138]*, see Table 28. Based on this result, severe obese status was not a predictor of neonate low birthweight. Therefore, the cases of neonate birthweight among women with severe obese status were not significant (*p = 0.159)* compared to women who are very severely obese. Thus, women with severe obese status were at similar risk

(*OR = 1.056*) of neonate low birthweight compared to women of very severe obese status.

Table 28

Unadjusted estimate of BMI (very severe obese and severe obese) and neonate birthweight

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B) Lower	Upper
Step 1[a]	Maternal with very severe obese			17.462	3	.001			
	Maternal with normal BMI	.112	.030	13.519	1	.000	1.118	1.053	1.187
	Maternal with moderate obese	.115	.034	11.389	1	.001	1.122	1.049	1.199
	Maternal with severe obese	.054	.038	1.985	1	.159	1.056	.979	1.138
	Constant	1.029	.029	1269.023	1	.000	2.799		

a. Variable(s) entered on step 1: Maternal BMI

The model summary of the severe versus very severe obese status prediction of neonate low birthweight is shown in Table 29. The Cox and Snell R square model showed that none (0%) of the neonate low birthweight could be explained by severe obese status in the absence of accounting for the confounders. Also, the Nagelkerke R square model also suggested that none (0%) of the neonate low birthweight outcomes could be explained by severe obese status.

Table 29

Unadjusted model summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	105575.704[a]	.000	.000

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Summary of Findings

In this study, three levels of obesity categories: moderate, severe, and very severe obesity were used to explore preterm births and neonate birthweight. An analysis was conducted on preterm, neonatal birthweight, obese status (moderate, severe, and very severe), and the confounders (income, education age, marital status, race, and ethnicity. Inferential analysis for the three research questions were conducted with and without accounting for the confounders (income, education age, marital status, race, and ethnicity).

For RQ1, the prevalence of preterm birth women with either moderate, severe, or very severe obese status was compared to women with a normal body weight. Without accounting for the confounders (income, education age, marital status, race, and ethnicity), results indicated that women who are moderately obese, severely obese, and very severely obese positively predicted preterm birth outcomes when compared to women with a normal weight. After accounting for age alone, women who were moderately obese, severely obese, and very severely obese were statistically significant in predicting preterm birth outcomes compared to women with a normal body weight. However, when all other stated confounders (education, income, age, race, marital status, and ethnicity) were added in the analysis, all the obesity categories (moderate, severe, and very severe) showed no statistically significant prediction of preterm birth outcomes when compared to women with a normal body weight. In terms of unadjusted prevalence estimates, among the population used in this current study, the prevalence of women with moderate, severe, and very severe obesity who had a preterm birth is approximately 56 preterm births per 1000 births while the prevalence of women with moderate, severe, and very severe obesity has 43 preterm births per 1000 live births.

For RQ2, the association between neonate birthweight of babies born from women who are very severely obese was compared to the neonate birthweight of babies born from women who are moderately obese. Without accounting for any confounder, women with moderate obesity were statistically significant in positively predicting neonate low birthweight outcome when compared to women of very severe obesity. After accounting for all the confounders stated above, women who were moderately obese was still statistically significant in predicting low neonate birthweight. For RQ3, the association between neonate birthweight of babies born from women who are very severely obese was compared to the neonate birthweight of babies born from women who are severely obese. Without accounting for the any of the confounders stated above, severe obese was not associated with neonate low birthweight when compared to very severe obesity.

Chapter 5: Discussion, Conclusions, and Recommendations

Maternal obesity needed to be explored to advance effective health promotion and preventative measures regarding birth-related risks factors among maternally obese women. The purpose of this study was to examine the associations between three levels of obesity (moderate, severe, and very severe) and preterm birth and neonate birthweight among women of reproductive ages (18-39). In addition, I evaluated the difference in the prevalence of preterm birth among women of obese status and normal weight.

Interpretation of the Findings

In this study, I evaluated the effects of three obesity statuses (moderate, severe, and very severe) on preterm births and neonate birthweight. Three research questions and hypotheses were used to guide the study. The risk factor (or independent variable) for the three research questions and hypotheses was obesity status. The dependent variable or outcome of interest for RQ1 was preterm birth. The dependent variable for RQ2 and RQ3 was low birthweight.

Association between Preterm Birth and Moderate, Severe, and Very Severe Obesity

For RQ1, the prevalence of preterm birth among women of moderate, severe, and very severe obese statuses was compared to that of women with normal body weight using the binary logistic regression model. After accounting for income, education, age, marital status, race, and ethnicity, the preterm birth cases among women with moderate obese status compared to women of with a normal body weight were statistically significant ($p^{***} < 0.001$, 95% CI [0.712, 0.840]). Women with moderate obese status were compared to women with a normal body weight, and the observed preterm birth risk was lower (*OR* = 0.773). When women with severe obesity were compared to those with normal body weight, the preterm birth outcome was statistically significant ($p^{***} < 0.001$, 95% CI [0.663, 0.825]). However, when women with severe obesity were compared to women with a normal body weight, the preterm birth outcome risk was lower (*OR* = *0.*740; 26% lower odds). Similarly, the difference in preterm birth outcomes between women with very severe obesity compared to those with normal body weight was statistically significant ($p^{***} < 0.001$, 95% CI [0.649, 0.829]). However, when women with very severe obesity were compared to women with normal body weight, the preterm birth outcome risk was also lower (*OR* = 0.733; 27% lower odds), as shown in Table 19.

The current findings were different from the observation made by Cnattingius et al. (2013), which showed that there was a statistically significant association between early pregnancy BMI and risk of preterm delivery by gestational age and precursors of preterm delivery. Cnattigus et al. found that women with a BMI value 30 to <35 had an OR = 1.58 [95% CI 1.39-1.79]. Those who had a BMI value 35 to <40 had an OR = 2.01 [95% CI, 1.66-2.45], and those with a BMI value 40 or greater had an OR = 2.99 [95% CI, 2.28-3.92] (Cnattigus et al., 2013). Cnattigus et al. concluded that there was an increase in the risk of spontaneous extremely preterm deliveries among women whose BMI value was 30 or higher and that the risk of medically indicated preterm deliveries increased as BMI increased among women who were overweight and obese.

Also, Vinturache, McKeating, Daly, and Sheehan (2016) assessed the association between maternal BMI and risk of spontaneous preterm deliveries and elective preterm deliveries. According to Vinturache et al., the risk estimation of preterm delivery was higher among overweight and obese multiparous women (women having previous birth). For elective preterm deliveries and obese women, the adjusted OR (aOR) was 2.8 [95% CI 1.7 to 4.4] (Vinturache et al., 2016). Also, severe obesity increased the risk of both spontaneous preterm deliveries represented with an aOR of 1.4 [95%CI 1.01 to 2.1] and elective preterm deliveries with an aOR of 1.4 [95% CI 1.1 to 1.8] in singleton pregnancies. The risk estimation described by both Cnattingius et al. (2013) and Vinturache et al. was higher in contrast with the apparent inverse or lack of association observed in the current study.

Prevalence. In the current study, the prevalence of preterm birth among women with obese statuses (moderate, severe, and very severe) was 56 preterm births per 1,000 live births. On the other hand, the prevalence of preterm birth among women with normal body weight was 43 preterm births per 1,000 live births.

Confounding by age. After accounting for age alone, women who were moderately obese, severely obese, and very severely obese were still statistically significant, $p^{***} < 0.001$, in predicting preterm birth (babies born < 28 weeks) outcomes compared to women with a normal body weight. Lamminpää et al. (2016) explored pregnancy outcomes of overweight and obese women ages 35 years and older. When using women who were < 35 years of age as a reference group, Lamminpää et al. found that women who were categorized as overweight and obese showed an increase risk of preterm birth and fetal deaths (BMI 25-29, *OR* = 2.12 [95%CI, 1.54—2.92] and BMI ≥30, *OR*= 0.79 [95%CI, 0.68—0.92] respectively) when compared to women of normal weight. Based on the current study, the risk (OR) of preterm birth in women ages 20-39 years with OR range of 0.212-0.371 were statistically significant, $p^{***} < 0.001$, when women ages 18-19 years were used as the reference group. When accounting for age alone, women with moderate, severe, and very severe obese statuses were compared to those with a normal body weight. The preterm birth outcome risk estimate was as follows: moderate *OR* = 0.802 (20% lower odd of preterm birth), severe *OR* = 0.761 (24% lower odds of preterm birth), very severe *OR* = 0.774 (23% lower odds of preterm birth) compared to normal weight, and statistically significant $p^{***} < 0.001$, as shown in Table 16. Based on these findings, the null hypothesis was rejected.

Accounting for confounders effects on preterm birth. When education, income, age, race, marital status, and ethnicity were added to the analysis, moderate, severe, and very severe obese status did not predict preterm birth when women with a normal body weight were used as the reference, as shown in Table 19.

Accounting for education effects on preterm birth. When education was accounted for, there was a linear relationship between education and preterm birth among women who were moderate, severe, and very severely obese. Using elementary/junior high school as the reference, the preterm birth risk among women with some high school education was *OR* = 0.596, $p = 0.001$, 95% CI [.443, .802], while those who completed college or higher education was *OR* = 1.843, $p^{***} < 0.001$, 95% CI [1.343, 2.527]. This indicated that women who completed college or higher education were 1.84 times more likely to have preterm birth or have 85% higher odds of preterm births. However, preterm birth outcomes among women who had lower education, and those with some college education, were not significantly associated to obese status when compared to women with an elementary or junior high school education level, as shown in Table 19.

Accounting for income effects on preterm birth. When income was accounted for using federal poverty level as the reference, the risk of preterm birth outcomes among low-income women *OR* = 1.244, *p* = 0.032 95% CI [1.018, 1.519] and middle-income women were statistically significant *OR* = 1.374, *p**** < 0.001, 95% CI [1.219, 1.549] for preterm birth outcomes when compared to women who were at the federal poverty income level. Women with low income were 1.24 time more likely to have preterm birth or had 24% higher odds of preterm birth compared to women at the federal poverty level. Also, women at middle-income were 1.37 times more likely to have preterm birth or had 37% higher odds of preterm birth compared to women at federal poverty level.

Accounting for age effect on preterm birth. When age groups were accounted for, and age group 18-19 years old was used as the reference, the risk of preterm birth outcomes in other age groups was statistically significant. Information is described as follows: age 20-24; *OR* = 0.255, *p**** < 0.001, 95% CI [0.176, 0.371], age 25-29; *OR* = 0.148, *p**** < 0.001, 95% CI [0.102, 0.214], age 30-34; OR = 0.109 *p**** < 0.001, 95% CI [0.075, 2.158], age group 35-39; *OR* = 0.087, *p**** < 0.001, 95% CI [0.059, 0.128]. Based on these findings, women ages 20-24 years had 75% lower odds of preterm birth. Women ages 25-29 years had 85% lower odds of preterm birth. Women ages 30-34 years had 89% lower odds of preterm birth and women ages 35-39 years had 91% lower odds of preterm birth when compared to women ages 18-19 years.

Accounting for race effect on preterm birth. When race was accounted for with Other-Asian used as the reference, the risk of preterm birth outcomes in other race groups was statistically significant. This is described as follows: Black; *OR* = 0.508, *p**** <0.001, 95% CI [0.361, 0.715], White *OR = 0.595*, *p* = 0.002, 95% CI [0.427, 0.829], American Indian *OR* = 0.597, *p* = 0.010, 95% CI [0.403, 0.885], AK Native; *OR* = 0.579, *p* = 0.006, 95% CI [0.393, 0.852]. Based on this information, Black women had 49% lower odds of preterm birth when compared to women of Other-Asian. White women had 40% lower odds of preterm birth when compared to women who were Other-Asian race. American Indian women had 40% lower odds of preterm birth, and women who were Alaskan Natives had 42% lower odds of preterm birth when compared to women who were Other-Asian.

Accounting for marital status effect on preterm birth. When marital status was accounted for and married status was used as the reference, the risk of preterm birth outcomes among women of unmarried, and unknown marital statuses were not statistically significant therefore was not a predictor of preterm birth.

Accounting for ethnicity effect on preterm birth. When ethnicity was accounted for and Hispanic was used as the reference, the risk of preterm birth outcomes among Non-Hispanic was not statistically significant and thus, ethnicity was not a predictor of preterm birth.

Association of Neonate Birthweight and Very Severe and Moderate Obesity

For RQ2, the association between neonate birthweight of babies born from women who are very severely obese was compared with the neonate birthweight of babies born from women who are moderately obese. In a study by researchers Moss and Chugan (2014), they explored the increased risk of low birthweight, rapid postnatal growth, and autism in underweight and obese mothers. Findings indicated, there was high risk of low birth weight among children born by underweight mothers *OR* = 2.27, 95% CI [1.39, 3.70] and obese mothers *OR* = 1.75, 95% CI [1.32, 2.31] (Moss and Chugan, 2014). In my study, without accounting for any the confounders, the risk of moderate obesity was statistically significant (*OR* = 1.122, *p* = 0.001, 95% CI [1.049, 1.199]) in predicting neonate low birthweight outcomes when compared to women of very severe obese status. Women of moderate obesity had 12% higher odds of neonate low birthweight when compared to women who were very severely obese. Therefore, the null hypothesis suggesting that ‘there is no association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are moderately obese should be rejected.

Accounting for confounders to assess the association of neonate birthweight. When confounders: education, income, age, race, marital status, and ethnicity were added to the analysis, moderate obesity were statistically significant, *OR* = 1.095, p = 046, 95% CI [1.002, 1.198] in predicting low neonate birthweight. Hence, moderately obese women had 10% higher odds of low neonate birthweight.

Accounting for education effect on neonate birthweight. When education level was accounted for and elementary/junior education was used as the reference, the risk of low birthweight outcomes among women with some high school education and high school graduates were statistically significant and predictors of low birthweight, *OR* =

0.775, $p = 0.002$, 95% CI [0.661, 0.908] and *OR* = 0.820, $p = 0.011$, 95% CI [0.704, 0.955] respectively. In other words, women with some high school had 23% lower odds of low neonate birthweight and women with some high school had 18% lower odds of low neonate birthweight when compared to women with elementary/junior high school education. As a result, the null hypothesis should be rejected. On the other hand, women with some college education and those who completed college or had higher education showed no association with low neonate birthweight when compared to women with elementary/ junior high school education.

Accounting for income effect on neonate birthweight. When income level was accounted for and federal poverty level was used as the reference, the risk of low birthweight outcomes among women with low income and middle income were statistically significant and predictors of low birthweight, *OR* = 1.149, $p = 0.005$, 95% CI [1.042, 1.267] and *OR* = 1.259, $p^{***} < 0.001$, 95% CI [1.187, 1.334] respectively. Women with low-income level had 15% higher odd of neonate low birthweight while middle-income women had 26% higher odds of neonate low birthweight when compared to women at federal poverty level. The income relationship was linear.

Accounting for age effect on neonate birthweight. When age group was accounted for and age group 18-19 years was used as the reference, the risk of low birthweight outcomes among women 30-34 and 35-39 years were statistically significant and predictors of low birthweight, *OR* = 0.847, $p = 0.001$, 95% CI [0.765, 0.936] and *OR* = 0.712, $p^{***} <0.001$, 95% CI [0.636, 0.797] respectively. Therefore, when women ages 18-19 years were used as he reference group, women ages 30-34 years had15% lower odds of neonate low birthweight and women ages 35-39 years had 29% lower odds of neonate low birthweight.

Accounting for race effect on neonate birthweight. When accounting for race with Other-Asian race used as the reference, the risk of low neonate birthweight outcomes of White, American Indian, and Chinese were statistically significant and described as follows: White OR = 0.744, p*** <0.001, 95% CI [0.653, .848]), American Indian OR = 1.755, p*** <0.001, 95% CI [1.452, 2.122]) and Chinese OR =1.597, p = 0.002, 95% CI [1.191, 2.140]. Bases on this finding, when women of the Other-Asian race were used as the reference group, White women had 15% lower odds of neonate low birthweight. American Indian women had 76% higher odds of neonate low birthweight and Chinese women had 60% higher odds of neonate low birthweight.

Accounting for marital status effect on neonate birthweight. When marital status was accounted for and married status was used as the reference, the risk of neonate low birthweight outcomes among women who were not married were statistically significant, $OR = 0$.865, p*** < 0.001, 95% CI [0.821, 0.911]) and therefore a predictor of low neonate birthweight. In other words, women who were not married had 14% lower odds of neonate low birthweight.

Accounting for ethnicity effect on neonate birthweight. When ethnicity was accounted for and Hispanic was used as the reference, the risk of neonate low birthweight outcomes among women of Non-Hispanic ethnicity was statistically significant, OR = 1.473, p*** < 0.001, 95% CI [1.363, 1.592]), suggesting that non-Hispanic women had 47% higher odds of neonate low birthweight and thus a predictor of low neonate birthweight. The observed findings also supported Coley and Nichols (2016) who demonstrated that confounders such as race, age and neighborhood socioeconomic status had associations to low birthweight. Also, Agorinya et al. (2018) demonstrated that education, income, marital status and age were contributing factors or risk factors of low birthweight.

Association of Neonate Birthweight on Very Severe Obesity and Severe Obesity

For RQ3, the association between neonate birthweight of babies born from women who are very severely obese when compared with the neonate birthweight of babies born from women who are severely obese. In this assessment, without accounting for any of the confounders stated above, severe obese women were not a predictor of neonate low birthweight when compared to women of very severely obesity. Therefore, for RQ3, the null hypothesis was not rejected.

As described above, the study obese status (moderate, severe, and very severe) and the confounders/covariates relationship to preterm birth and neonate birthweight were explained through the lens of the social-ecological theory’s constructs microsystem, mesosystem, exosystem, macrosystem and chronosystem. The income impact on preterm and neonate birthweight was explained by the microsystem. The obese status and age groups were linked to the mesosystem of the socio-ecological theory. The marital status effects or influence on preterm birth and neonate birthweight stood alone and reflected the characteristics of the exosystem as described in chapter 2 of this dissertation. The education level, race, ethnicity, and income as well were explained by and reflected the macrosystem of the socio-ecological theory. Similarly, the impact of the maternal education and income levels on preterm birth and neonate birthweight was explained through the lens of the chronosystem as well.

Limitations of the Study

The use of secondary data was a limitation because the purpose of PRAMS data collection is not primarily to assess obesity among pregnant women. CDC PRAMS used a survey questionnaire that was mailed 2-4 months after delivery and contains items regarding early post-partum period that can be a sensitive topic to the mothers. The self-reported survey responses were not supported with clinical data for each individual respondent. It is possible that mothers experiencing post-partum stage of delivery or those trying to cope or adjust to their new baby's needs did not have quality time to answer the surveys accurately. Rumination bias could have occurred as these women may lack focus/ interest in answering the survey questions due to time constraint, burden, sleepless night, and stress associated with new delivery, thus, negative emotion may distort their experiences and create a temporarily stress-induced recall bias.

The sampling approach for the study skewed the race and ethnicity representations. For example, based on the descriptive analysis 61% of the women were white and the rest are other races. Similarly, about 82% of the population used in this study was Hispanic, approximately 15% Non-Hispanics, and 3% unknown. It is possible that the disproportional representation of the sample population could distort the findings of the study to induce either a Type I/false positive conclusion or Type II error/false-negative conclusion. No causal association could be inferred using the findings of this study. Also, no generalization could be made beyond the population used in this study.

Recommendations

Further investigation of women of obese statuses and neonate birthweight status should be advanced to include high birthweight and overweight statuses. It would also be purposeful to reassess the PRAMS questionnaire regarding race and ethnicity to clarify and understand how race and ethnicities were affected in PRAMS data set in terms of improving the proportional representation samples based on race, ethnicity, and income levels in the data set sampling procedures. In order to improve this study, women who may have had potential pre-existing health conditions would have been excluded or the health status such as diabetes or preeclampsia should be accounted for. Other variables such as alcohol consumption and smoking could also be covariates to account for in a future study, as they were not discussed in this study. The CDC data was collected at the state level, however; in this study, did not look at and neonate low birthweight outcomes by state. Further studies using the CDC data should explore the maternal and infant outcomes by state to identify states with increased risks to help address the need of the at risk states and to prevent further increase in adverse maternal, infant, and neonate outcomes.

Implications

Based on the findings from this study, women with moderate, severe, and very severe obesity should be continuously monitored and referred by health care professionals to obesity lifestyle change programs such as Weight Watchers or Skinny Genes to reduce adverse health outcomes. These women should also be engaged in programs promoted by the National Institute of Health such as Maternal & Child Health

Training (MCH) Nutrition, which promotes nutrition education and management. For instance, the current RQ1 findings suggested higher prevalence of preterm birth outcomes (56 preterm births per 1000 live births) among women of obese statuses compared to women of normal weight body weight (43 preterm births per 1000 live births). The current findings regarding the impact of obesity on preterm birth described above in RQ1 was different from Salihu, Lynch, Alio, and Liu (2008) results in terms of the preterm birth risk assessment. This current study's finding indicated that obese women had lower risk of preterm birth compared to women of normal body weight, which did not support the findings of Salihu et al. (2008). The findings of Salihu et al. (2008) used Missouri maternally linked cohort data from 1989 through 1997 to examine the association between maternal obesity subtypes and the risk of spontaneous versus medically induced preterm birth in singletons and twins. After adjusting for education, marital status, maternal smoking, prenatal care, weight gained during pregnancy, maternal height, gender of the infant, birth year, and maternal race, the authors concluded that obese or very obese mothers had a higher risk (*OR*= 1.56, 95% CI: 1.42, 1.72) or (*OR* = 1.71, 95% CI: 1.50, 1.94) respectively for spontaneous preterm births compared to non-obese mothers (Salihu, Lynch, Alio, & Liu, 2008). This study's findings regarding the prevalence of preterm birth among obese (moderate, severe, and very severe) women was higher than among women with a normal body weight which further supports the need for enhanced surveillance of preterm cases among the population at risk identified in this study. It is important that public health agencies (state and local) and health systems work together to continue to document, report, and refer obese patients or individuals to lifestyle change programs that is tailored to help individuals with obese condition loss weight and maintain healthy weight and lifestyle.

Moderate obese status positively predicted neonate low birthweight outcome when compared to women of very severe obesity because the focus of the study is to assess the difference in association between low birthweight between women of moderate and very severe obesity status. After accounting for all confounders, women who were moderately obese were still statistically significant in predicting low neonate birthweight. Women who were severely obese were not a predictor of low birthweight when compared to women who were very severely obese. This study's current findings supported McDonald, Han, Muilla, and Beyene (2010) study, which examined the relationship between overweight and obese mothers, and preterm, and low birthweight in singleton pregnancies among women in developed and developing countries using a systematic review and meta-analysis approaches. The authors concluded that there was a lower risk (*OR* = 0.84, 95% CI, 0.75, 0.95) of low birthweight in singleton births among overweight and obese compared to women with normal body weight (McDonald, Han, Muilla, & Beyene, 2010). McDonald et al. (2010) also concluded that the heavier the woman (overweight, obese, very obese), the higher the risk of extremely low birthweight. Therefore, the need for continued public health support and surveillance are warranted to address the public health need to help reduce the high burden of preterm birth and low birthweight cases among population at risk.

To help address the issues of preterm birth and low birthweight related to obesity among pregnant women, statewide and local efforts should focus on recommending or legislation regarding lifestyle or behavioral change enrollment/attendance as a reimbursable service and should be paid for by private insurance and Medicare. Life style change programs tailored on obesity reduction could help improve health literacy among target population to reduce the incidence and prevalence of obesity and to encourage the overall public health community wellness plan.

Conclusion

In this study, I explored the relationship between women of moderate, severe, and very severe obese statuses and the prevalence of preterm birth and its association with low neonate birthweight. For RQ1, after accounting for confounders, there was no association between preterm birth among women of normal weight and moderate, severe, and very severe obese status associated with preterm birth. For RQ2, there was positive association with or without accounting for the confounders between moderate obesity and neonate low birthweight when compared to women with very severe obese status as the reference group. In contrast, for RQ3, without accounting for the confounders, there was no association between women with severe obesity and neonate low birthweight when compared to women with women of very severe obese status as the reference group. However when accounting for confounders, the neonate low birthweight among women who are severely obese was statistically significant compared to those of women who are very severe obese.

By understanding the health impacts such as preterm birth and low birthweight among women at obese levels such as moderate, severe, and very severe, meaningful positive social change could be advanced in the local, regional public health areas, community levels, and at point of medical services by increasing referrals to lifestyle change programs. The current study supports the need to promote health professionals' involvement in community linkages building for weight loss programs. In addition, surveillance programs tailored to weight gain should be a priority within local health departments to monitor vulnerable women and pregnancies at risk. This study will inform agencies such as Women Infant Child to empower the at-risk population through increasing health literacy and awareness. These findings could inform programs tailored to weight loss programs. Programs tailored towards preventative care can be informed by this study to justify their goals and objectives in advancing health promotion measures.

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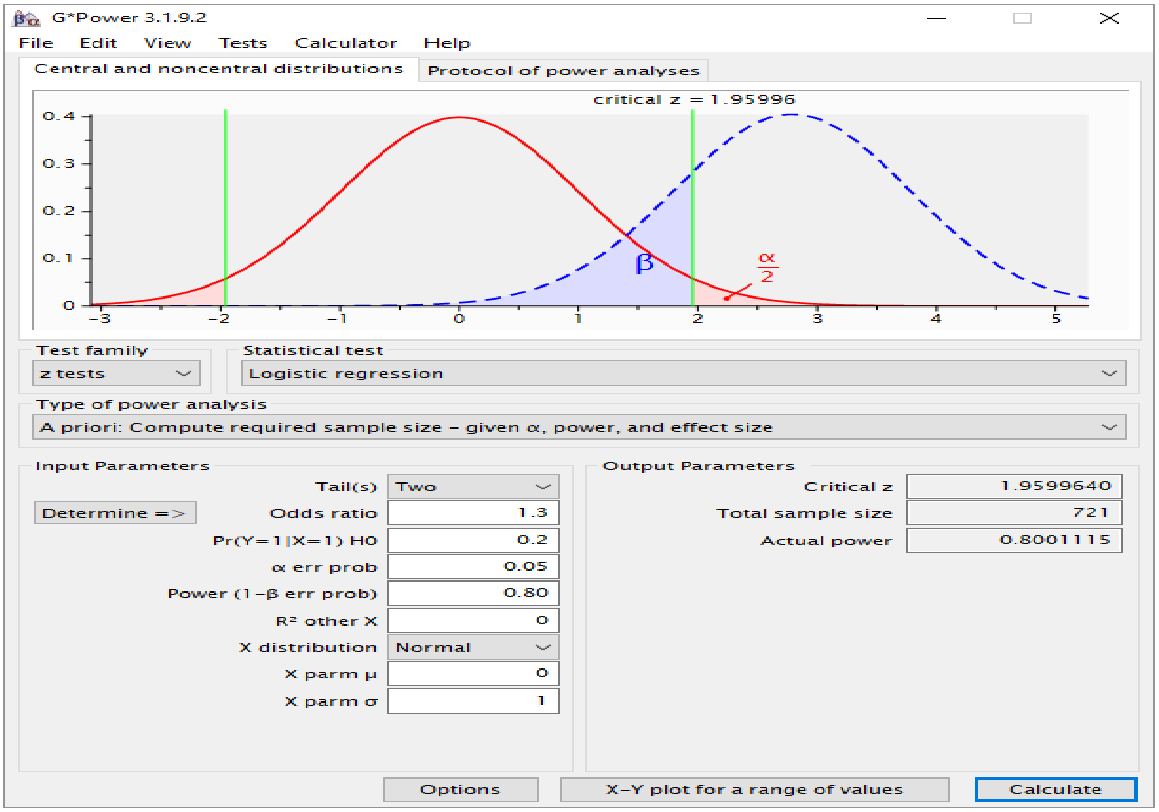
Appendix A: G*Power



[1] -- *Saturday, December 16, 2017 -- 16:45:25*

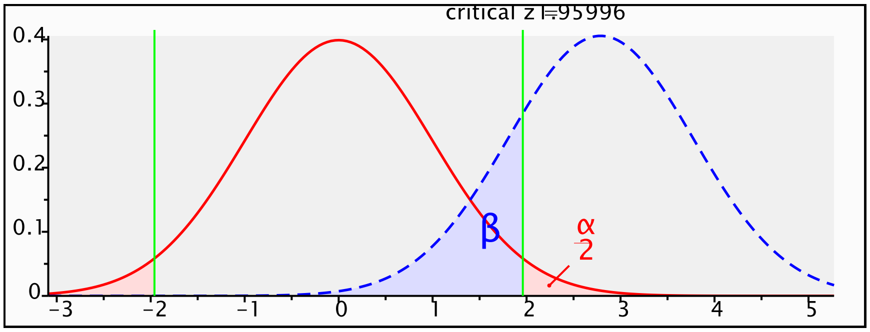
z tests - Logistic regression

Options: Large sample z-Test, Demidenko (2007) with var corr

Analysis: A priori: Compute required sample size

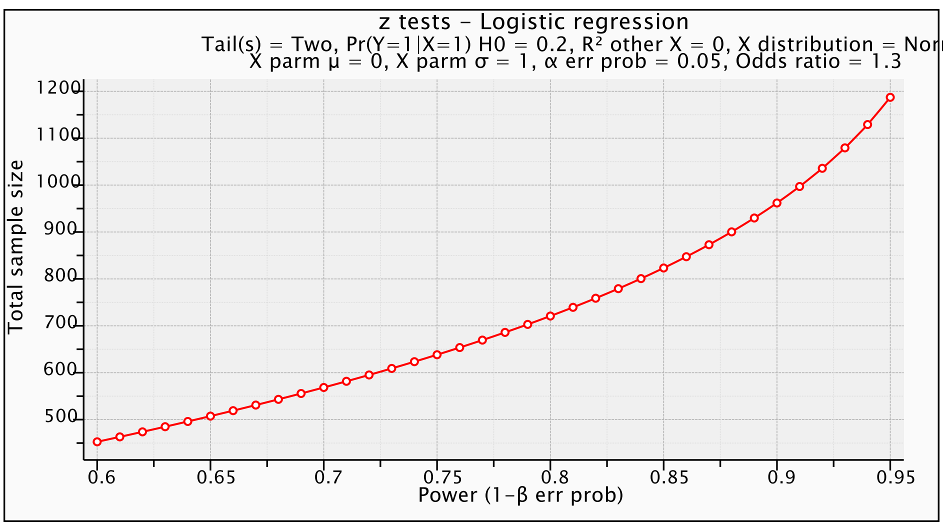
Input:	Tail(s)	=	Two
	Odds ratio	=	1.3
	Pr(Y=1|X=1) H0	=	0.2
	α err prob	=	0.05
	Power (1-β err prob)	=	0.80
	R^2 other X	=	0
	X distribution	=	Normal
	X parm μ	=	0
	X parm σ	=	1
Output:	Critical z	=	1.9599640
	Total sample size	=	721

Actual power = 0.8001115



The participants' eligibility that met the inclusion/exclusion criteria for the study are women who had at least a baby or had a preterm birth. In order to determine the samples size for this study GPower was used and paraemetters considered was a logistic regression where α

error probability is .05 and Power (1-β err prob) is .95. The total sample size will be 988.



Appendix B: PRAMS

Pregnancy Risk Assessment Monitoring System (PRAMS) Proposal Application Form

Please complete one form per proposal

Date:	
Principal researcher's name and Title:	
Principal researcher's affiliation*:	
Address (no P.O. boxes—please provide physical address):	
Phone number:	
E-mail address:	
Names and affiliations* of other researchers:	
Proposal title:	
Proposal keywords (i.e. prenatal care, oral health, postpartum, etc.)	

**Researchers affiliated with CDC's Division of Reproductive Health (DRH), should give early consideration to include a representative from the PRAMS Team as a co-author or in an acknowledgement.*

Appendix C: Data Sharing Agreement

External Researcher Data Sharing Agreement

CDC PRAMS AGREEMENT FOR SHARING MULTI-STATE DATA WITH EXTERNAL RESEARCHERS

I, ______________________________, as principal investigator/coinvestigator on this proposed analysis of Pregnancy Risk Assessment Monitoring System (PRAMS) data, agree to the following requirements for the use of PRAMS data and assure compliance with the requirements by all staff and collaborators approved as part of this agreement.

1. I will not use these data except for statistical analysis and reporting as described in the attached proposal, titled ____ ______________________________, which accompanies this statement.

2. I will not use nor permit approved collaborators and staff to use these data to conduct analyses other than those described in the proposal.

3. I will not release the data set or any part of it to any person other than those listed as collaborators in the attached proposal. I will assure that all approved collaborators understand that they may not share the data set or any part of it.

4. I will neither attempt, nor permit others to attempt, to use the data set or link it with other data sets to learn the identity of any participant. If the identity of a respondent should be inadvertently discovered, I will not use and/or distribute this information, nor will I permit others to use the information. I will inform the CDC PRAMS staff at PRAMSProposals@cdc.gov of the discovery but will not disclose any identifiable data in the e-mail, so they can prevent future discoveries. I pledge that neither I nor other members of my team will inform anyone else of this knowledge.

5. All oral or written presentations of the results of the analyses will include an acknowledgment of the PRAMS Working Group and the Centers for Disease Control and Prevention (CDC).

6. All oral or written presentations of the results of the analyses will be submitted to the CDC at least 3 weeks prior to presentation or submission to a journal so presentations can be forwarded to the PRAMS participating states for their information. States will have two weeks to submit comments on the presentation/manuscript to the author. The acronym "PRAMS" will be submitted as a keyword for any publication.

7. CDC PRAMS staff and staff from states whose data were used in the analysis will be notified upon final publication of an article and provided with citation information.

8. When the proposed analyses are completed, all copies of these data will be destroyed (confirmed in writing to PRAMSProposals@cdc.gov) or returned to CDC.

My signature and the signatures of all co-investigators indicate our agreement to comply with these requirements.

Name of principal investigator:

Title and Organization:

Signature: ______________________________ Date: ______________________

Name of collaborator:

Signature: ______________________________ Date: ______________________

Appendix D: Data Use Agreement

DATA USE AGREEMENT

This Data Use Agreement ("Agreement"), effective as of (Enter date.) ("Effective Date"), is entered into by and between (Enter researcher's name.)("Data Recipient") and (Enter community partner name.) ("Data Provider"). The purpose of this Agreement is to provide Data Recipient with access to a Limited Data Set ("LDS") for use in research in accord with the HIPAA and FERPA Regulations.

1. Definitions. Unless otherwise specified in this Agreement, all capitalized terms used in this Agreement not otherwise defined have the meaning established for purposes of the "HIPAA Regulations" codified at Title 45 parts 160 through 164 of the United States Code of Federal Regulations, as amended from time to time.

2. Preparation of the LDS. Data Provider shall prepare and furnish to Data Recipient a LDS in accord with any applicable HIPAA or FERPA Regulations

Data Fields in the LDS. **No direct identifiers such as names may be included in the Limited Data Set (LDS).** The researcher will also not name the organization in the doctoral project report that is published in ProQuest. In preparing the LDS, Data Provider or designee shall include the **data fields specified as follows**, which are the minimum necessary to accomplish the research: (List the datapoints essential to the research that will be released.).

3. Responsibilities of Data Recipient. Data Recipient agrees to:

    a. Use or disclose the LDS only as permitted by this Agreement or as required by law;

    b. Use appropriate safeguards to prevent use or disclosure of the LDS other than as permitted by this Agreement or required by law;

    c. Report to Data Provider any use or disclosure of the LDS of which it becomes aware that is not permitted by this Agreement or required by law;

    d. Require any of its subcontractors or agents that receive or have access to the LDS to agree to the same restrictions and conditions on the use and/or disclosure of the LDS that apply to Data Recipient under this Agreement; and

    e. Not use the information in the LDS to identify or contact the individuals who are data subjects.

4. Permitted Uses and Disclosures of the LDS. Data Recipient may use and/or disclose the LDS for its research activities only.

5. Term and Termination.

a. Term. The term of this Agreement shall commence as of the Effective Date and shall continue for so long as Data Recipient retains the LDS, unless sooner terminated as set forth in this Agreement.

b. Termination by Data Recipient. Data Recipient may terminate this agreement at any time by notifying the Data Provider and returning or destroying the LDS.

c. Termination by Data Provider. Data Provider may terminate this agreement at any time by providing thirty (30) days prior written notice to Data Recipient.

d. For Breach. Data Provider shall provide written notice to Data Recipient within ten (10) days of any determination that Data Recipient has breached a material term of this Agreement. Data Provider shall afford Data Recipient an opportunity to cure said alleged material breach upon mutually agreeable terms. Failure to agree on mutually agreeable terms for cure within thirty (30) days shall be grounds for the immediate termination of this Agreement by Data Provider.

e. Effect of Termination. Sections 1, 4, 5, 6(e) and 7 of this Agreement shall survive any termination of this Agreement under subsections c or d.

6. Miscellaneous.

a. Change in Law. The parties agree to negotiate in good faith to amend this Agreement to comport with changes in federal law that materially alter either or both parties' obligations under this Agreement. Provided however, that if the parties are unable to agree to mutually acceptable amendment(s) by the compliance date of the change in applicable law or regulations, either Party may terminate this Agreement as provided in section 6.

b. Construction of Terms. The terms of this Agreement shall be construed to give effect to applicable federal interpretative guidance regarding the HIPAA Regulations.

c. No Third Party Beneficiaries. Nothing in this Agreement shall confer upon any person other than the parties and their respective successors or assigns, any rights, remedies, obligations, or liabilities whatsoever.

d. Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute one and the same instrument.

e. Headings. The headings and other captions in this Agreement are for convenience and reference only and shall not be used in interpreting, construing or enforcing any of the provisions of this Agreement.

IN WITNESS WHEREOF, each of the undersigned has caused this Agreement to be duly executed in its name and on its behalf.

DATA PROVIDER **DATA RECIPIENT**

Signed: ______________________________ Signed: ________________________

Print Name: __________________________ Print Name: ______________________________

Print Title: ___________________________ Print Title: ______________________________