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Pregnancy Associated Conditions and Birth Outcomes Among Georgia Mothers: A Population-based Study

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ABSTRACT

Introduction: Georgia has one of the highest rates of maternal mortality in the nation with 30.2 pregnancy-related deaths per 100,000 live births between 2018-2020. Pregnancy-associated conditions (PACs) are associated with maternal mortality and negative birth outcomes. Evidence supports that pre-pregnancy overweight, and obesity are associated with weight gain, increased body mass index (BMI) during pregnancy, gestational hypertension (GHT), and gestational diabetes mellitus (GDM) which in turn are associated with adverse birth outcomes. The primary objective of the study is to investigate the risk of pre-pregnancy BMI associated with adverse maternal conditions and birth outcomes among Georgia mothers after controlling for demographics and other covariates.

Methods: The study used secondary data from Georgia's Department of Public Health (DPH) birth certificate and natality data for the year 2022 (N=129,723). Descriptive analyses were conducted to examine pre-pregnancy BMI, maternal characteristics, the incidence of BMI during pregnancy, hypertension, gestational diabetes, and birth outcomes (birth weight, premature birth, and cesarian method of delivery). Logistic regression modeling was utilized to assess the association between pre-pregnancy BMI and PACs and to estimate the adjusted odds ratio (AOR) while controlling for maternal demographics and covariates.

Results: Based on pre-pregnancy BMI, mothers were grouped into normal (36%), overweight (27%), and obese (34%). The incidence of GHT is 9.3%, and GDM is 6.7%, while more than one-quarter of the mothers are overweight (29%), and two-thirds are obese (62%), during pregnancy. Mothers who are obese before pregnancy are nearly 3 times more likely to have GHT (AOR= 2.81, 95%CI= 2.68, 2.95), 3 times more likely to experience GDM (AOR=2.89, 95%CI=

2.73, 3.05), and over 300 times likely to stay obese during pregnancy (AOR=360, 95% CI= 281, 463). Regarding the mother's age, we found a consistent increase in the odds of becoming overweight/obese and having GDM during pregnancy. Women of Hispanic descent (AOR=1.22, 95%CI=1.15, 1.30) have a 1.2 times likelihood of being obese during pregnancy, whereas other groups such as Hawaiian/Pacific islander (AOR=1.21, 95% CI=0.64, 2.31), and non-Hispanic Black/African American (AOR=1.10, 95%CI=1.05, 1.15) also had a higher chance of being obese. Non-Hispanic Black/ African American (AOR=1.02, 95% CI=0.97, 1.06) descent was found to have the highest odds of developing GHT than mothers of a different racial/ethnic identity. The highest chance of a mother developing gestational diabetes was in Asian mothers (AOR=2.27, 95% CI=2.09, 2.46) have nearly 2.3 times higher odds for GDM compared to white mothers. Birth outcomes such as birth weight and delivery through the cesarian method had a strong significant relationship across all PACs. Mothers with GHT (AOR=2.82, 95%CI= 2.28, 2.95) and mothers with GDM (AOR=1.46 95%CI= 1.38, 1.55) have higher odds of having a premature birth (<37 weeks of gestation). Mothers who are overweight/obese have higher odds of giving birth to a macrosomia baby (AOR=3.13, 95%CI= 2.73, 3.59).

Conclusion: These findings are consistent with data on maternal health and birth outcomes. Pre-pregnancy BMI ≥30 among women enhances the risk that leads to a myriad of pregnancy-associated conditions and negative birth outcomes. Maintaining a healthy weight through a balanced diet and regular physical activity before becoming pregnant can help reduce these risks. Our study highlights the importance of physical health and good prenatal care before pregnancy. Although making healthier individual choices is key these choices could be hindered by social, economic, and environmental factors such as stress, low income, food insecurity, vehicle dependence, and more that can keep mothers from a healthier lifestyle.

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A Population-based Study

by

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Approval Page

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Author's Statement Page

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List of Abbreviations

- PAC- Pregnancy-associated Conditions
- BMI- Body Mass Index
- GDM- Gestational Diabetes Mellitus
- GHT- Gestational Hypertension
- DPH- Department of Public Health
- AOR- Adjusted Odds Ratio
- CI- Confidence Interval
- MMR- Maternal Mortality ratio
- LBW- Low Birthweight
- CS- Caesarean Section
- CDC- Centers for Disease Control and Prevention

CHAPTER I: INTRODUCTION

The term “Maternal mortality” describes the death of a mother from pregnancy-related health issues or an existing condition exacerbated by pregnancy (NICHD, 2023). Maternal mortality ratio (MMR) is calculated based on the rate of death for mothers in the population (death/population). Pregnancy-associated conditions (PACs) can indicate the increased likelihood of negative birth outcomes including low birth weight, premature birth, and delivery via caesarian section. PACs include body mass index (BMI) during pregnancy, gestational hypertension (GHT), and gestational diabetes mellitus (GDM). Certain maternal characteristics together with pre-pregnancy BMI can increase the likelihood of these conditions leading to maternal mortality.

1.1 Pregnancy-Associated Conditions in the United States

In recent years, pregnancy and maternal health have been a persistent topic of political, healthcare, and public health discourse in the United States. With the overturning of Roe v. Wade, researchers are predicting potential increases in maternal health and negative birth outcomes in the southern region due to trigger laws (Bendix et al., 2022). In addition to policies that dictate women’s access to quality healthcare, negative maternal health conditions are more proportionate in women who are minorities, low income, and lack access to care or resources, such as weight control, and lifestyle interventions (Bendix et al., 2022). Adverse pregnancy outcomes are important in research because of the consistent rise in rates along with the severity and sudden onset of symptoms. PACs can include many morbid conditions that make the prenatal and postpartum health of the mother and child worse and may result in mortality. The

World Health Organization (WHO) recognized that about 75% of all maternal deaths included severe bleeding, infection, high blood pressure (preeclampsia and eclampsia), delivery complications, and unsafe abortion. Several other conditions may contribute to negative maternal and birth outcomes including hemorrhage, thrombosis, hypertension, and cardiovascular disease (Kilapatrick, 2015). Many of these conditions are preventable through mandated risk assessment of the mother, however, the United States has yet to implement such mandates for pregnancies in general.

An annual estimate found that 700 mothers die in the United States from maternal complications, and 40,000–50,000 suffer from maternal morbidities such as low birth weight and preterm birth (Valerio et al., 2023). The incidence of maternal mortality can be further categorized by racial/ethnic characteristics, socioeconomic status (indicators of SES), and education. For example, mothers who are Black/African American have higher rates of maternal mortality than any other group, this is also the case for PACs such as body mass index (BMI) during pregnancy, gestational hypertension, and gestational diabetes.

1.2 Notable Risk Factors associated with Maternal Mortality in the state of Georgia.

Georgia is one of the three states with the highest rates of maternal mortality in the nation between 2018 and 2020 with 30.2 pregnancy-related deaths per 100,000 live births (Georgia Department of Public Health, 2023). Research indicates that the risk factors most associated with maternal mortality include age, race/ethnicity, low educational attainment, obesity (BMI $\geq$ 30), lack of prenatal care, cesarean method of delivery, hemorrhage, and hypertension (Diana et al., 2020, Goffman et al., 2007).

Significant racial-ethnic differences continued to exist in maternal mortality and pregnancy-related conditions. Race/ethnicity are important health indicators due to systemic racism within medical care practices and the disparities in treatment when compared to other racial identities. For example, Non-Hispanic Black women are 2.7 times more likely to die from pregnancy-related causes than Non-Hispanic White women (Howell, 2023).

Pregnancy-associated conditions including BMI during pregnancy, Gestational Hypertension (GHT), and Gestational Diabetes Mellitus (GDM); are all recognizable indicators for negative maternal and birth outcomes. In addition to the rising obesity rates of women in not just the United States but specifically Georgia, it is important to detail why these conditions are critical in overall prenatal and maternal health. Research indicates that an increased BMI during pregnancy and pre-pregnancy BMI are the strongest evidence for GDM (Giannakou et al., 2019). The rate of overweight and obesity (BMI ≥ 25kg/m2) for women of reproductive age is about 32% for national standards linked to those adverse pregnancy outcomes (Van Hoorn et al., 2021). The same can be said for GDM which has been studied extensively through the lens of racial disparities, finding that these disparities persist this day within prenatal and postnatal care. Further research into predictive factors of these pregnancy-related conditions is marked by maternal characteristics.

1.3 Birth Outcomes

Birth outcomes are a range of expected and unexpected outcomes derived from childbirth. These include birthweight, premature birth (before 37 weeks of gestational age), cesarian method of delivery, male/female sex ratio, and mortality. A prematurely born child is underdeveloped and requires special care to sustain its life. March of Dimes is a site dedicated to

keeping up with the latest Peri statistics across the United States. In 2021, Georgia had 11.9% of premature live births.

A meta-analysis assessed over 20 million pregnant women's pre-pregnancy BMI and found that women who are overweight or obese are more likely to experience several negative birth outcomes including cesarian delivery, macrosomia, low birth weight, and extreme preterm birth (Vats et al., 2021; Goldstein et al., 2018). Gestational Hypertension is another risk factor for adverse birth outcomes, related to premature birth (Venkatesh et al., 2022). Premature birth can have additional risks such as breathing problems, feeding problems for the child, injury to the body, problems with the uterus, cervix, or placenta, infections, and other issues with blood pressure and diabetes (Howson et al., 2013; Ward & Beachy, 2003). Prematurity occurs at a gestational age of less than 37 weeks, which can contribute to underdevelopment but also other birth outcomes.

Distinct disparities exist in birth outcomes based on maternal demographics including race/ethnicity, age, socioeconomic status, lifestyle, and maternal health behaviors. Delivery by cesarian section (c-section) is considered an adverse outcome due to the severe complications that can occur such as infection, heavy bleeding, and increased risk of uterine tearing if a vaginal delivery is attempted afterward. Although c-sections are a viable alternative to vaginal delivery at times when a particular pregnancy is high risk, they can also come with problems that should be accurately assessed due to a high chance of infection and other major complications. In Georgia, 35.1% of live births are delivered through a c-section, and 10.6% of live births are low birthweight (LBW) in 2021 (March of Dimes, 2023).

Birth weight is measured during the infant's initial examination and can have a considerable impact on healthcare needs at birth or later in life. Infants born small for gestational

age (SGA), or low birth weight (<2500gms) are more likely to have low blood sugar, prenatal asphyxia, and impaired thermoregulation. Abnormal gestational weight is associated with a slew of potential risks, usually predetermined by the mother's preexisting conditions during pregnancy. Macrosomia (>4000gms) can contribute to a developing child's insulin resistance, diabetes, obesity, early development of cardiovascular disease, and multiple forms of cancer (Hunt et al., 2012).

1.4 Purpose of the study

The goal of this thesis is to investigate the association between pre-pregnancy BMI (as a primary risk factor) and pregnancy-associated conditions, (Body Mass Index (BMI) during pregnancy, Gestational Hypertension, and Gestational Diabetes), birth outcomes (low birth weight, macrosomia, preterm birth, and c-section) among Georgia mothers.

Georgia Natality Birth Certificate data from 2022 is used to examine the outcomes and their suspected predictors. By conducting a population-based study, investigators sought to examine the incidence of pregnancy-associated conditions (PAC), birth outcomes, and maternal demographics. Pregnancy conditions include BMI during pregnancy, Gestational Hypertension, and GDM, which can contribute to poor birth outcomes and maternal mortality. Related birth outcomes have a significant impact on the health of the mother and infant born with the following outcomes: low birth weight, macrosomia, premature birth, and delivery through cesarean section all have a multi-generational effect on overall health and eventual birth outcomes for a female child (Howson et al., 2013; Shrestha et al., 2010; Witt et al., 2014).

1.4.1 Study Objectives and Research Questions

Objective 1:

To examine the incidence of primary outcomes of interest including Body Mass Index (BMI) during pregnancy, Gestational hypertension (GHT), and Gestational Diabetes Mellitus (GDM) in Georgia mothers. Maternal demographics (Age, Race/Ethnicity, Education Insurance Type, Use of WIC, and, Multiple births,) were examined.

Research Question 1:

What is the incidence of pregnancy-associated conditions: Hypertension, gestational diabetes, and BMI during pregnancy in Georgia mothers in 2022?

Research Question 2:

What are the demographic factors of the mothers who had given birth to live babies and their association with pregnancy-associated conditions?

Objective 2:

The primary focus of objective 2 is to investigate the association of pre-pregnancy BMI (underweight, healthy, overweight, and obese), the primary risk factor of interest with pregnancy-associated conditions of mothers in 2022.

Research Question 3:

Is a mother's Pre-Pregnancy BMI (underweight = 18.5, healthy = 18.5- <25, overweight = 25- <30, and obese 30- <35+) a risk factor for pregnancy-associated conditions adjusting for demographics (e.g., Age, Race/ethnicity, education, insurance)?

Objective 3:

The third objective is to examine the incidence of birth outcomes including premature birth, macrosomia, low birth weight, Cesarian method of delivery, and their associated risk with PACs. Investigating birth outcomes will allow for proper assessment of preexisting disparities of PACs when controlling for maternal demographics.

Research Question 4:

What is the incidence of Birth outcomes including premature birth, low birth weight, and c-section, and their association with PACs?

1.4.2 Conceptual Framework

The conceptual frame that guides this research as shown in Figure 1, provides a roadmap for the investigation of relationships among risk factors and outcomes of interest. In this framework, maternal demographics (age, race, ethnicity, education, and health insurance) will predict pregnancy-associated conditions (PACs) that can influence the incidence of birth outcomes for this study.

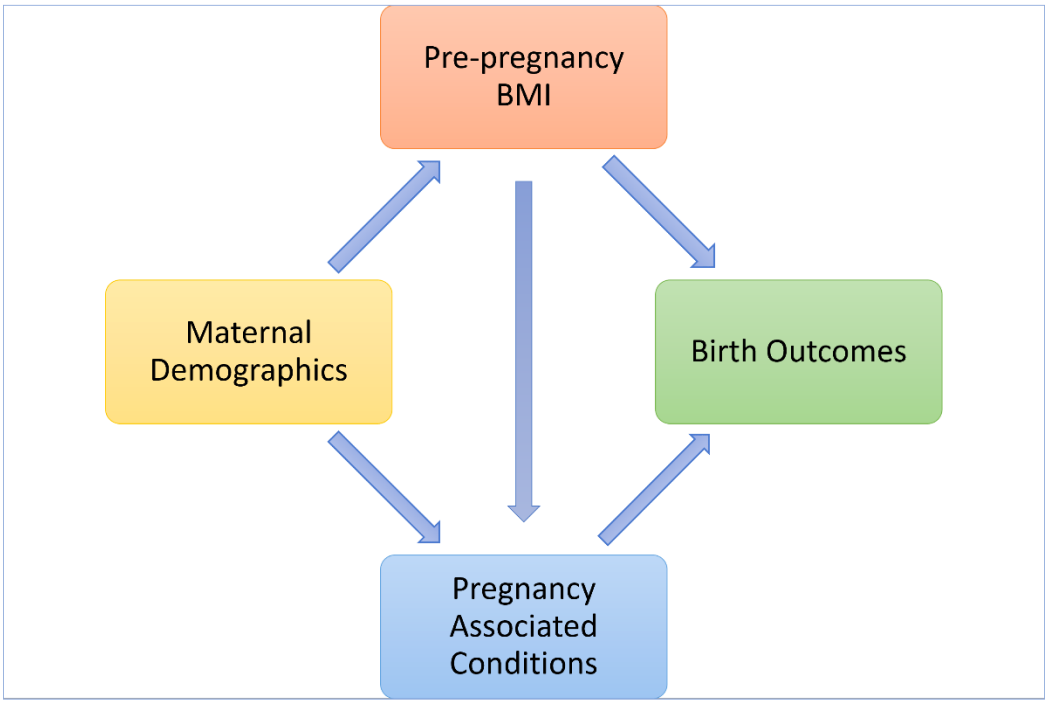

Figure 1: A Conceptual Model on the relationship between maternal characteristics and pregnancy-associated condition's effect on birth outcomes.

The model states that maternal demographics (age, race, ethnicity, education, and health insurance) potentially contribute to pre-pregnancy BMI, which in turn may be linked to pregnancy weight gain, overweight and obese conditions during pregnancy, Gestational Hypertension, and Gestational Diabetes influencing birth outcomes. In addition to PACs, a mother's pre-pregnancy BMI can also have a direct link to birth outcomes. The birth outcomes included in this study are Premature birth (gestational age <37 weeks), LBW, weight <2500 grams (about 5.51 lb.), and macrosomia (4000+ grams); delivery by c-section.

CHAPTER II: LITERATURE REVIEW

2.1 Importance of Maternal Mortality

Maternal healthcare is an incredibly important sector in the United States healthcare, but our healthcare system has problems stemming from a lack of meaningful assessment of patient safety, low healthcare professional-to-patient ratio, and low wages. With the lack of universal healthcare like much of the developed world, the United States still falters in decreasing the incidence of maternal mortality. Data derived from the CDC's Morbidity Mortality Weekly Report (MMWR) data in the United States has seen an incline of severe maternal mortality from 1998-2011 from 0.6% to 1.6% (Kilapatrick, 2015). Maternal health is a great indicator of population health, as prenatal and post-partum conditions can affect both the mother and child in the future. The latest research studies state that mothers who develop pregnancy-associated conditions have a greater likelihood of experiencing negative birth outcomes, making the infant more susceptible to negative health conditions later in life (Martin-Calvo et al., 2022).

2.2 Risk Factors of Maternal Morbidity

Maternal risk factors are a combination of pregnancy-associated conditions and birth outcomes that can set the stage for maternal morbidity. Such exposures and conditions include Pre-pregnancy BMI, BMI during pregnancy, gestational hypertension, and gestational diabetes. The World Health Organization demonstrates that the most common etiology of Severe Maternal Morbidity (SMM) has been hemorrhage and hypertensive disorders (Geller et al., 2018).

2.2.1 Body Mass Index (BMI)

Body Mass Index (BMI) is the calculation based on the person's height and weight, used as a baseline indicator of health. Weight categories are used to measure whether someone is underweight, healthy weight, overweight, or obese. Maternal obesity (BMI ≥30) is associated with severe maternal mortalities which include GDM, GHT, preeclampsia, and stroke (Sunder et al., 2022, Giannakou et al., 2019). Previous research on population-based cohort studies indicates that a higher pre-pregnancy BMI is also associated with asthma and delivery by the cesarian section in addition to GHT and GDM (Leonard et al., 2020) which further increases the risk of maternal mortality.

2.2.2 Gestational Hypertension

Gestational Hypertension (GHT) or high blood pressure occurs when pressure in the blood vessels is too high (≥140/90 mmHg), which many mothers may not even know that they have. Gestational hypertension can influence cardiovascular health, through coronary heart disease, heart failure, stroke, and cardiovascular mortality which accounts for about 44% of postpartum mortality (Cameron et al., 2022). GHT is typically diagnosed after 20 weeks or closer to the delivery date, and in most cases is gone after birth. The overall rate of GHT between 1987 – 2004 increased from 10.7 to 30.6 per 1000 deliveries (Cameron et al., 2022). This implies a change in maternal health that is exacerbating adverse maternal conditions. Research also indicates that gestational hypertension is another major risk factor that can lead to adverse birth outcomes such as preterm birth (Venkatesh et al., 2022)

2.2.3 Gestational Diabetes

Gestation Diabetes Mellitus (GDM) commonly develops during pregnancy, when the mother's body cannot produce enough insulin from the pancreas. CDC research states that women who have insulin resistance. For example, research that assessed differences between Black and American Native women with Gestational Diabetes was four times that of White women and other adverse pregnancy conditions, finding that there are persisting racial and ethnic disparities in pregnancy and birth outcomes (Venkatesh et al., 2022).

2.3 Birth Outcomes

Birth outcomes are measured conditions that allow physicians to gauge the health of the infant once delivered such as the gestational age measured in weeks and defined as the period between conception and birth) birthweight (measured in grams), and delivery method (vaginal or cesarian). These outcomes indicate the status of reproductive health within populations. According to the United States Centers for Disease Control (US CDC), more than three million healthy babies are born annually in the United States. Nonetheless, a proportion of the annual births show adverse conditions in the neonates. Adverse birth outcomes are multifactorial outcome that includes preterm birth, low birth weight, stillbirth, macrosomia, congenital anomaly, and infant/neonatal death. All outcomes are common health problems consisting of several health effects involving pregnancy and the newborn infant. Birth outcomes may be different across geographic areas due to access, level of care, social and environmental exposures, and behavioral characteristics.

2.3.1 Low Birth Weight

Most babies born between 37 and 40 weeks weigh somewhere between 5 pounds, 8 ounces (2,500 grams) and 8 pounds, 13 ounces (4,000 grams). Low birth weight (LBW) is described as the newborn's weight of less than 2,500 grams (about 5 lb.) at birth, while a very low birthweight is a weight of less than 1500 grams (Collins et al., 1997). Emerging evidence has found that LBW has perinatal effects on health later in life such as childhood obesity and adult onset of type 2 diabetes (Martin-Calvo et al., 2022).

2.3.2 Macrosomia

Described as a weight greater than 4000 grams (about 8.82 lb.) at birth. Previous research indicates that this birth outcome can be influenced by the mother's development of gestational diabetes mellitus (GDM) during pregnancy or being overweight (BMI <30) during pregnancy (Wang et al., 2020). Associated risk factors of a mother having an infant with macrosomia can affect their later development by increasing the risk of obesity regardless of infant sex, and type 2 diabetes in male adults (Wang et al., 2020). Research has suggested that maternal obesity, weight gain during pregnancy, and gestational diabetes mellitus (GDM) are risk factors that can determine an infant's birth weight at gestational age (Hunt et al., 2012).

2.3.3 Premature Birth

Premature Birth is the birth of a child before the gestational age of 37 weeks (about 8 and a half months), which increases the risk of an infant being underdeveloped and in need of additional medical care. For example, they may have malformed organs such as the brain, lungs, and liver which could lead to developmental delay, the child not being able to breathe on their own, hearing, and feeding problems (CDC, 2022). Other developmental disabilities such as

cerebral palsy, and vision problems are caused by premature birth. The CDC also states that maternal characteristics in which premature birth can become more common are teen pregnancies, women over the age of 35, black/African American women, and women from low-income/ low socio-economic status.

2.3.4 Cesarian-Section

A cesarian section (CS) is a surgical procedure in which the abdomen and uterus are cut open to remove a newborn that is either planned for an emergency or when a vaginal birth is not viable or unsafe. In many cases, a CS is necessary for those who need it, as it is recommended to improve 10% to 15% maternal and postnatal outcomes, alongside preventing adverse maternal and infant mortality and morbidity (Temmerman et al., 2021). Emerging evidence found that infants born through CS have different hormonal, physical, bacterial, and medical exposures that can alter neonatal physiology (Temmerman et al., 2021, Sandell et al., 2018). Risks can include altered immune development such as allergy, atopy, and asthma, along with reduced intestinal gut microbiome diversity, respiratory tract infection, and obesity (Temmerman et al., 2021) The adverse maternal outcomes of CS can include anemia, urinary tract infection, wound dehiscence (surgical incision opening), and endometritis (Miseljic et al., 2020). Other more severe causes of maternal mortality include a preexisting condition becoming worse, bleeding, acute heart failure, and even the inability to give birth vaginally after the first CS delivery.

CHAPTER III: METHODOLOGY

This study is a population-based prospective cohort design and is observational. Cohort studies are used to study incidence, causes, and prognosis. Because they measure events in chronological order they can be used to distinguish between cause and effect.

3.1 Data Source and Data Collection

This research study utilized secondary data originally collected by Georgia's Department of Public Health (DPH) which included records of all live births during the year 2022. The data file includes the number of mothers who gave live birth, and each row represents the mother (N=129,723) and her data relevant to maternal and prenatal conditions, birth outcomes, geospatial characteristics, and demographics.

Data were collected based on federal mandates for national collection and publication of births and other vital statistics by cooperating with the National Center for Health Statistics (NCHS) and each state providing access to their birth certificates (CDC, 2023). In Georgia specifically, the health department is centralized allowing them to fund regional health districts throughout the state, making it possible to collect health data from all 159 counties in the state (DPH, 2022). Each health department receives birth certificate data from hospitals, clinics, and urgent care centers as they occur. Besides birth certificates, data were also obtained on birthweight, gestational age in weeks, delivery type, the mother's age at delivery, race/ethnicity, education level, type of health insurance, whether the mother qualified for WIC, the mother's pre-pregnancy BMI, mother's BMI during pregnancy, gestational hypertension, and gestational diabetes.

3.2 Ethical Considerations

The study has been approved by Georgia State University's institutional review board under the exception category that is appropriate for the use of secondary data sources.

3.3 Measurement and Variables

The data file provided by the GDPH file included information on the mother and the live-born child. The variables included in the study are:

Outcome variables of interest

Pregnancy-associated conditions:

- *Pregnancy BMI:* BMI during pregnancy was derived using the mother's weight in kilograms (or pounds) divided by the square of height in meters (or feet) and was provided in the data file as a continuous numerical variable. The categorical BMI measure was created using the CDC's classification as underweight is ≤ 18.5, healthy ≥18.5 - ≤25, overweight is ≥ 25 - ≤30, and obese is ≥ 30.
- *Gestational Hypertension (GHT)*: as indicated in the birth certificate and maternal data on a binary scale of 0 (condition not found) and 1(condition found).
- *Gestational Diabetes Mellitus (GDM):* as indicated in the birth certificate and maternal data on a binary scale of 0 (condition not found) and 1(condition found).

Birth outcomes:

- Low birth weight: Newborn's birth weight was recorded in natality data as a continuous numerical variable measured in grams. Using birth weight, infants who weighed less than 2500 grams (about 5.51 lb.) were grouped as LBW, and infants greater than 2500 grams were grouped under normal weight.

- Premature birth: The gestational age of the newborn was collected in weeks as a continuous variable, then categorized as normal (38 weeks or greater) and premature birth if born before 37 weeks.
- Delivery Type: Collected as a categorized variable on whether the baby was delivered through a vaginal canal or via a cesarian section. Missing data for this variable is 0.1%.

Independent factors:

The primary independent factor of interest

- *Pre-pregnancy BMI:* Primary risk factor of interest, pre-pregnancy BMI was derived using the mother's weight in kilograms (or pounds) divided by the square of height in meters (or feet) and was provided in the data file as a continuous numerical variable. The categorical BMI measure was created using the CDC's classification as underweight is ≤ 18.5, healthy ≥18.5 - ≤25, overweight is ≥ 25 - ≤30, and obese is ≥ 30.
- *Maternal demographic information:*
  a) Maternal age: The mother's age was measured in years at the time of delivery as a continuous variable and was transformed into a categorical variable: >20, 21-25, 26-30, 31-35, and 35+. These categories were derived around the process of pregnancy, during the time in which pregnancy is most likely to occur.
  b) Race and ethnicity: Race information was collected as a categorical variable, for specific racial groups: White, Black/African American, Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, and Multi-racial. Ethnicity was collected on a binary scale with 0 indicating that the person was non-Hispanic, and 1 indicating that they were Hispanic. These two variables were then combined so

that Ethnicity could be captured as a unique category besides the racial group. A final list of the combined categories in Non-Hispanic White, Non-Hispanic Black/African American, Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, Multi-racial, and Hispanic. Race was recorded as one answer per section, so if a mother is biracial (Ex. Black and White), they could only be recorded as multi-racial.

c) Maternal Education: The mother's education was categorized as less than 9th-grade education, some high school education, high school graduate or GED, and some college education. Missing Data for this variable is 0.4%.

d) Economic indicators: These are multiple variables that capture aspects of assistance that the birth mother has depending on their income or economic status. This includes the Georgia Women, Infant, and Children's (WIC) program which allows women and/or guardians to be eligible to receive healthy food, for children under the age of five to meet nutritional requirements. WIC has an income requirement based on the household's size and the type of health insurance they have. Payor was the variable that measured what type of health insurance they had. This variable was then recorded into Insurance Type, government (receiving Medicaid, and other government assistance), private/commercial (including Tricare, Commercial Insurance, and other/self. Missing data for Insurance is 0.2%.

e) Prenatal Care Month Begin: A measure of when the mother began receiving prenatal care during pregnancy month (Months 1 to 10).

f) Plurality: A variable that measures the instance in which a mother has a singleton (one child) or multiple births (twins/triplets).

Other covariates:

- Weight gain during pregnancy was a continuous variable measured in pounds and was converted to a categorical variable based on the CDC's categories for weight gain among pregnant women. The categories represent how much weight is normal weight gain in women during pregnancy based on their pregnancy weight to manage any new or preexisting conditions. The categories created include ≤ 24lbs, 25-35lbs, 36-45lbs, and ≥46lbs.

Missing Data:

- When the data was initially collected, some variables had missing data lines. However, much of the missing data accounted for less than 0.5% of the total cohort. Variables that included missing data were Insurance Type, mother's education, and delivery method.

3.4 Statistical Analysis

The initial data were provided in a text document, each row representing a mother, and each column was a variable. A text document was used to be easily transferred into programs utilizing CSV or Excel just in case the other programs were more useful. The document was then transferred to SPSS (Statistical Package for the Social Sciences) version 28.0, to transform the data and convert variables into a usable format. A descriptive analysis was conducted on the maternal characteristics of the study population to contrast pregnancy-associated conditions and birth outcomes. A multivariate logistic regression was also performed for each of the PACs by carefully selecting the variables based on bivariate analyses (chi-square- and univariate regression).

Descriptive Statistics:

Univariate analysis was conducted on all variables to examine the distribution, data quality, and potential coding errors. To achieve objectives one and three, univariate descriptive analysis was performed on maternal demographics, pregnancy-associated conditions (PAC), and birth outcomes to obtain the frequency and percentages for each variable. Frequencies (counts) and percentages of each variable are presented in a table format. Maternal demographics are presented in Table 1, PACs in Table 2, and birth outcomes in Table 3.

Inferential statistics:

Inferential statistics included bivariate analysis for testing the association between the independent predictors (maternal demographics, pre-pregnancy BMI) and outcomes of interest, BMI during pregnancy, Gestational Hypertension, Gestational diabetes, and birth outcomes (c-section, premature birth, and LBW). To complete objective two, we examined the logistic regression formed by analyzing the relationship between pre-pregnancy BMI and maternal characteristics. These variables are then compared to the three main conditions to assess the significance of the Pearson chi-square and confidence interval for each variable and adjusting for maternal demographics. The P value was set at >0.05 for significance.

To complete the third objective, we examined the incidence of birth outcomes of premature birth, LBW, macrosomia, CS, and their associated risk factors with maternal characteristics between the outcomes such as the mother's age, race/ethnicity, education, type of health insurance, whether the mother received WIC, the month that prenatal care began, and weight gain during pregnancy.

Multivariate Analyses:

Multivariate analyses were conducted to answer research question 3 under objective 2. For multivariate analysis, binary logistic regression was performed to estimate the adjusted odds ratios (AOR) and P-value of >0.05 for significance. The variables that entered the model were chosen based on their importance and significance at the bivariate level (chi square-univariate regression). The logistic regression was performed on each of the PACs (BMI during pregnancy, Gestational Hypertension, and Gestational Diabetes Mellitus), regressed on Pre-pregnancy BMI, maternal demographics (Age, Race/ethnicity, Insurance Type, Weight gain during pregnancy), covariates (weight gained during pregnancy), and birth outcomes (premature birth, birthweight, and delivery type). All factors were entered into the model at the same time.

CHAPTER IV: RESULTS

4.1 Descriptive statistics

4.1.1 Participants Demographics

The following section describes population demographics including maternal, infant characteristics/birth outcomes, and pregnancy-associated conditions. Table 1 presents the descriptive statistics in counts and percentages and mean age with standard deviation.

More than three-quarters (78.1%) of the mothers were between the ages of 21 and 35. A small proportion of mothers are younger than 21 years. Most of the mothers reported as non-Hispanic white (43.3%) or as black/African American (33.2%). Over 56% of the mothers have some college education, and over 90% of the study population utilizes government or private/commercial insurance. 73% of pregnant women began receiving prenatal care within the first trimester. One-quarter of the mothers received food from the WIC program. Most births were singletons (96%).

Table 1: Demographic Characteristics of Study Population (N=129,723))

Demographic Factor	Frequency	%
Age		
<20	10,236	7.9
21-25	28,860	22.2
26-30	38,376	29.6
31-35	34,074	26.3
35+	18,177	14.0
Race/Ethnicity		
Non-Hispanic White	56,111	43.3
Non-Hispanic Blk/AfrAm	43,055	33.2
Asian	5,637	4.3
AmInd/AlaskNat	106	0.1

Table 1. Demographic Characteristics of Study Population (N=129,723) contd...

Demographic Factor	Frequency	%
NativeHawa/Pacific Is	136	0.1
Multi-Racial	3,167	2.4
Hispanic	21,511	16.6
Education		
≤11th Gade	14,192	10.9
High School Graduate or GED	42,043	32.4
Some College/College Graduate	73,002	56.3
Missing	486	0.4
Insurance Type		
Government	60,572	46.7
Private/Commercial	58,825	45.3
Other/Self	10,090	7.8
Missing	236	0.2
Prenatal care month beginning		
First Month	12,233	9.4
Second Month	37,770	29.1
Third Month	44,053	34.0
Fourth Month	14,255	11.0
Fifth month to tenth	15,478	11.9
Received WIC		
Yes	33,927	26.4
No	94,774	73.1
Plurality		
Singleton	125,161	96.5
Twins/Triplets	4,559	3.5
Missing	3	0.0

4.1.2 Pre-pregnancy BMI and pregnancy-associated conditions

Table 2 presents data on the study's primary focus of exposure and three outcomes of maternal conditions. Sixty-one percent of mothers reported being either overweight or obese

before their current pregnancy. Two-thirds of the mothers were categorized as obese and 29% as overweight. About 91% of women are overweight or obese during pregnancy. Gestational Hypertension was diagnosed in about 9% of pregnancies, and gestational diabetes in about 7% of pregnancies. The mean weight gain during pregnancy was 28.62 lbs. (SD=14.31).

Table 2: Pre-pregnancy BMI and Pregnancy-Associated Maternal Conditions

	Frequency	%
Pre-pregnancy BMI		
Underweight (<18.0)	4,228	3.3
Normal (18-25)	46,524	35.9
Overweight (25-30)	35,431	27.3
Obese (>30.0)	43,540	33.6
Pregnancy BMI		
Underweight (<18.0)	77	0.1
Normal (18-25)	11,114	8.6
Overweight (25-30)	37,221	28.7
Obese (>30.0)	80,858	62.3
Gestational Hypertension		
Yes	12,039	9.3
No	117,681	90.7
Missing	3	0.0
Gestational Diabetes		
Yes	8,628	6.7
No	121,092	93.3
Missing	3	0.0
Pregnancy Weight gain (in pounds)		
<24	51,237	39.5
25-35	35,692	27.5
36-45	18,024	13.9
46+	14,810	11.4
Mean (SD)	28.62(14.31)	

4.1.3 Birth Outcomes and Infant Demographics

Table 3 describes the infant data and birth outcomes reported in the birth certificate and natality data collection of the study population. Equal proportions of males (51.2%) and females (48.8%) were born during 2022. A little over one-third of the mothers delivered via a cesarian section. Most of the babies (83.4%) were born with normal birthweight, while about 10.6% had a very low(<1500gms) or low birthweight (<2500gms), and 6% had macrosomia (>4000 gms). There are about 12% of live births that took place prematurely before 37 weeks (8 and a half months) of gestational age.

Table 3:Infant Data and Birth Outcomes (N=129,732)

Demographic Factor	Frequency	%
Sex		
Male	66,379	51.2
Female	63,344	48.8
Delivery Method		
Vaginal Birth	83,951	64.7
Cesarean Section	45,661	35.2
Missing	111	0.1
Birthweight		
Very low/low birthweight (<2500gms)	13,753	10.6
Normal birthweight (2500 - 4000gms)	108,220	83.4
Macrosomia (>4000gms)	7,750	6.0
Birth Type		
Premature (<37 weeks of gestation)	15,461	11.9
Normal	114,262	88.1

4.2 Inferential statistics and hypothesis testing between independent factors and pregnancy-associated conditions.

4.2.1 Pregnancy BMI

For the bivariate analyses, the variable BMI during pregnancy was further grouped into a dichotomous variable. Mothers in the underweight category were combined with mothers of normal weight and labeled as normal; mothers in the overweight and obese category were merged into one group and labeled as obese.

Results from the bivariate analyses examining the association between BMI during pregnancy and independent factors are presented in Table 4. Out of the mothers with a pre-pregnancy BMI categorized as normal weight 22.1% stayed within this category while the other 77.9% gained weight during pregnancy and became obese. The mothers who were already overweight or obese before pregnancy, all were categorized as overweight, and those who were obese stayed obese during pregnancy. The majority of mothers across all age groups are overweight or obese ranging between 84% to 93%. The mothers with the lowest BMI during pregnancy based on race/ethnicity were Asian (16%) and American Indian/Alaskan Native (10.4%). However, most mothers were overweight or obese across all racial-ethnic groups ranging between 84 to 93%.

The majority of mothers across all education levels are overweight or obese ranging between 88% to 92%. Although most mothers across all insurance types are overweight or obese, the highest proportion (92%) was found among those with private/commercial insurance. Whether the mother received WIC assistance for food is not associated with BMI during pregnancy. A higher proportion (96%) of mothers who gave birth to twins/triplets are overweight or obese than mothers who give birth to singletons (91%).

Table 4: Bivariate associations between BMI during pregnancy and independent factors

Demographic Factor	(Underweight/ Normal weight)	(Overweight/ Obese)	P-value
	%	%	
Pre-pregnancy BMI (n)			.000
Under/Normal weight (50,357)	22.1	77.9	
Overweight (35,405)	0.2	99.8	
Obese (43,508)	0.0	100	
Age (n)			<.001
<20 (10,206)	16.1	83.9	
21-25 (28,763)	9.9	90.1	
26-30 (38,240)	7.6	92.4	
31-35 (33,954)	7.4	92.6	
35+ (18,107)	7.0	93.0	
Race/Ethnicity (n)			<.001
Non-Hispanic White (55,903)	8.8	91.2	
Non-Hispanic Blk/AfrAm (42,925)	8.1	91.9	
Asian (5,619)	15.8	84.2	
AmInd/AlaskNat (106)	10.4	89.6	
NativeHawa/Pacific Is (135)	7.4	92.8	
Multi-Racial (3,154)	9.2	90.8	
Hispanic (21,428)	7.4	92.6	
Education (n)			<.001
≤11th Grade (14,118)	11.7	88.3	
High School Graduate or GED (41,931)	9.2	90.8	
Some College/College Graduates (72,816)	7.7	92.3	
Insurance Type (n)			<.001
Government (60,432)	9.3	90.7	
Private/Commercial (58,744)	7.9	92.1	
Other/Self (9,941)	9.7	90.3	

Table 4. Bivariate associations between BMI during pregnancy and independent factors contd...

Demographic Factor	(Underweight/ Normal weight)	(Overweight/ Obese)	P-value
	%	%	
Received WIC (n)			0.627
Yes (33,845)	8.6	91.4	
No (94,508)	8.7	91.3	
Plurality (n)			<.001
Singleton (124,731)	8.8	91.2	
Twins/Triplets (4,539)	4.9	96.3	

4.2.2 Gestational Hypertension

Results from the bivariate analyses examining the association between gestational hypertension and independent factors are presented in Table 5. The proportion of the mothers who developed gestational hypertension (GHT) increased as a mother's pre-pregnancy BMI increased with the highest proportion (14%) among obese mothers. The proportion of mothers with GHT increased proportionally to the mother's age group.

The highest proportions of mothers that developed GHT during pregnancy were found among non-Hispanic Black/African American (10%), non-Hispanic White (10%), followed by American Indian/Alaskan Native (9.3%). Pregnant women with the highest proportion of gestational hypertension were those who have a high school diploma or GED (9.6%) compared to mothers with some college education or those who did not complete high school education.

Mothers who have government or private/commercial health insurance had the highest proportion of gestational hypertension. The highest proportion of mothers with GHT were those who did not receive assistance from WIC (10%). Mothers who give birth to twins/triplets (16%) had the highest proportion of gestational hypertension, compared to mothers who gave birth to singletons (9%).

Table 5:Bivariate associations between gestational hypertension and independent factors

Demographic Factor	Hypertension (Yes)	Hypertension (No)	P-value
	%	%	
Pre-pregnancy BMI (n)			<.001
Under/Normal weight (50,749)	5.5	94.5	
Overweight (35,431)	8.8	91.2	
Obese (43,540)	14.1	85.9	
Age (n)			<.001
<20 (10,236)	9.3	90.7	
21-25 (28,860)	9.7	90.3	
26-30 (38,375)	8.9	91.1	
31-35 (34,073)	9.0	91.0	
35+ (18,176)	10.0	90.0	
Race/Ethnicity (n)			<.001
Non-Hispanic White (56,111)	10.2	89.8	
Non-Hispanic Blk/AfrAm (43,052)	10.3	89.7	
Asian (5,637)	5.4	94.6	
AmInd/AlaskNat (106)	9.4	90.6	
NativeHawa/Pacific Is (136)	7.4	92.6	
Multi-Racial (3,167)	8.3	91.7	
Hispanic (21,511)	6.1	93.9	
Education (n)			<.001
≤11th Grade (14,192)	8.0	92.0	
High School Graduate or GED (42,043)	9.6	90.4	
Some College/College Graduates (73,002)	9.3	90.7	
Insurance Type (n)			<.001
Government (60,572)	9.7	90.3	
Private/Commercial (58,825)	9.4	90.6	
Other/Self (10,090)	6.5	93.5	

Table 5. Bivariate associations between gestational hypertension and independent factors contd...

Demographic Factor	Hypertension (Yes)	Hypertension (No)	P-value
	%	%	
Received WIC (n)			<.001
Yes (33,927)	10.4	89.6	
No (94,774)	8.9	91.1	
Plurality (n)			<.001
Singleton (125,161)	9.0	91.0	
Twins/Triplets (4,559)	15.7	84.3	

4.2.3 Gestational Diabetes Mellitus

Results from the bivariate analyses examining the association between gestational diabetes and independent factors are presented in Table 6. Mothers with a pre-pregnancy BMI categorized as obese had the highest proportion (10%) of gestational diabetes mellitus (GDM). The proportion of women with GDM increased with age with the highest at 11% among women over 35. The highest proportion of GDM was found in Asian (13.7%) women, twice the proportion of non-Hispanic white (6.5%), non-Hispanic black/African American (5.6%), and multiracial (6%) mothers. The proportion of mothers with GDM increased in women with some college or college graduates (7%). The highest proportion of GDM was found in women with private/commercial (7%) insurance. The proportion of women with gestational diabetes is the same whether the mother was eligible to receive WIC (6.7%) or not (6.6%). Mothers who gave birth to twins/triplets (8%), had a higher proportion of GDM, than mothers who gave birth to singletons (7%).

Table 6:Bivariate associations between Gestational Diabetes and potential independent factors

Demographic Factor	Gestational Diabetes (Yes)	Gestational Diabetes (No)	P-value
	%	%	
Pre-pregnancy BMI (n)			<.001
Under/Normal weight (50,749)	3.8	96.2	
Overweight (35,440)	6.3	93.7	
Obese (43,540)	10.2	89.8	
Age (n)			<.001
<20 (10,236)	2.4	97.6	
21-25 (28,860)	4.2	95.8	
26-30 (38,375)	6.1	93.9	
31-35 (34,073)	8.4	91.6	
35+ (18,176)	11.0	89.0	
Race/Ethnicity (n)			<.001
Non-Hispanic White (56,111)	6.5	93.5	
Non-Hispanic Blk/AfrAm (43,052)	5.6	94.4	
Asian (5,637)	13.7	86.3	
AmInd/AlaskNat (106)	7.5	92.5	
NativeHawa/Pacific Is (136)	8.8	91.2	
Multi-Racial (3,167)	6.0	94.0	
Hispanic (21,511)	7.3	92.7	
Education (n)			<.001
≤11th Gade (14,192)	6.2	93.8	
High School Graduate or GED (42,043)	6.0	94.0	
Some College/College Graduates (73,002)	7.1	92.9	
Insurance Type (n)			<.001
Government (60,572)	6.0	94.0	
Private/Commercial (58,825)	7.3	92.7	
Other/Self (10,090)	6.7	93.3	

Table 6. Bivariate associations between Gestational Diabetes and potential independent factors contd...

Demographic Factor	Gestational Diabetes (Yes)	Gestational Diabetes (No)	P-value
	%	%	
Received WIC (n)			.621
Yes (33,927)	6.7	93.3	
No (94,774)	6.6	93.4	
Plurality (n)			<.001
Singleton (125,161)	6.6	93.4	
Twins/Triplets (4,559)	8.4	91.6	

4.3 Multivariate analysis

Table 7 presents the results from multivariate logistic regression analyses performed on three main conditions: BMI during pregnancy, gestational hypertension, and gestational diabetes. Adjusted odds Ratios (AOR) and 95% confidence intervals (CI) are presented with a p-value set at 0.05 for significance. These analyses address research question 3 under objective 2.

Table 7:Results from Logistic Regression analysis reporting adjusted odds ratios and 95% CIs of risk factors for pregnancy-associated maternal conditions

	Pregnancy BMI (n=118467)	Gestational Hypertension (n=113367)	Gestational Diabetes (n=113367)
	AOD (95% CI)	AOD (95% CI)	AOD (95% CI)
Pre-pregnancy BMI (ref: Under/Normal weight)			
Overweight/Obese Φ	360 (281, 463) ***	_____	_____
Overweight	____	1.66 (1.57, 1.75) ***	1.71 (1.61, 1.82) ***
Obese	____	2.81 (2.68, 2.95) ***	2.89 (2.73, 3.05) ***

Table 7. Results from Logistic Regression analysis reporting adjusted odds ratios and 95% CIs of risk factors for pregnancy-associated maternal conditions contd...

	Pregnancy BMI (n=118467)	Gestational Hypertension (n=113367)	Gestational Diabetes (n=113367)
	AOD (95% CI)	AOD (95% CI)	AOD (95% CI)
Mother's Age (ref: <20)			
21-25	1.74 (1.63, 1.89) ***	1.04(0.96, 1.12)	1.79 (1.56, 2.06) ***
26-30	2.32 (2.18, 2.48) ***	0.95 (0.88, 1.02)	2.66 (2.33, 3.04) ***
31-35	2.40 (2.24, 2.56) ***	0.96(0.89, 1.04)	3.77 (3.30, 4.30) ***
35+	2.55 (2.36, 2.75) ***	1.07(0.99, 1.17)	5.06 (4.42, 5.80) ***
Race/Ethnicity (ref: white)			
Black/African Am.	1.1 (1.05, 1.15) ***	1.02 (0.97, 1.06)	0.85 (0.80, 0.89) ***
Asian	0.52 (0.48, 0.56) ***	0.51 (0.45, 0.57) ***	2.27(2.09, 2.46) ***
American Indian/ Alaskan Native	0.84 (0.45, 1.56)	0.92 (0.48, 1.77)	1.17 (0.57, 2.40)
Hawaiian/Pacific Islander	1.21 (0.64, 2.31)	0.70 (0.37, 1.34)	1.38(0.77, 2.51)
Multiracial	0.95 (0.84, 1.08)	0.80 (0.70, 0.91) ***	0.91(0.78, 1.06)
Hispanic	1.22 (1.15, 1.30) ***	0.58 (0.54, 0.61) ***	1.13 (1.07, 1.21) ***
Insurance Type (ref: Private/ Commercial)			
Government	0.95 (0.88, 1.02)	0.65 (0.59, 0.70) ***	1.12 (1.03, 1.22) **
Other/Self	1.12 (1.15, 1.25) ***	0.97 (0.93, 1.01)	1.24 (1.19, 1.30) ***

Table 7. Results from Logistic Regression analysis reporting adjusted odds ratios and 95% CIs of risk factors for pregnancy-associated maternal conditions contd...

	Pregnancy BMI (n=118467)	Gestational Hypertension (n=113367)	Gestational Diabetes (n=113367)
	AOD (95% CI)	AOD (95% CI)	AOD (95% CI)
Weight gain during pregnancy (Ref: <24lb.)			
25-35lb.	1.31 (1.25, 1.36) ***	0.83 (0.79, 0.87) ***	0.66 (0.63, 0.70) ***
36-45lb.	3.75 (3.45, 4.07) ***	1.00 (0.94, 1.06)	0.53 (0.49, 0.57) ***
45 +	20.69 (16.95, 25.2) ***	1.46 (1.38, 1.55) ***	0.56 (0.52, 0.61) ***
Premature birth (ref: Normal birth)			
Premature	0.74 (0.70, 0.78) ***	2.82 (2.70, 2.95) ***	1.46 (1.38, 1.55) ***
Birthweight (ref: Normal weight)			
Very low/low birthweight	0.54 (0.51, 0.57) ***	2.40 (2.28, 2.52) ***	1.06 (0.98, 1.13)
Macrosomia	3.13 (2.73, 3.59) ***	0.72 (0.66, 0.80) ***	1.35 (1.24, 1.46) ***
Delivery Method (ref: Vaginal birth)			
C-section	1.87 (1.79, 1.95) ***	1.77 (1.71, 1.84) ***	1.56 (1.49, 1.63) ***

* p<.05; ** p<.01; *** p<.001;

Φ Overweight and obese groups were combined for the logistic model run for pregnancy BMI; these groups were kept separate in the other two models.

4.3.1 Pregnancy BMI

Pre-pregnancy BMI was significantly associated with pregnancy BMI. If a mother is overweight/obese before becoming pregnant, her odds of becoming obese are over 300 times during pregnancy (AOR= 360, 95% CI= 281, 463).

Overweight/obese condition during pregnancy increased with age. Mothers who are older than 35 (AOR= 2.55, 95% CI=2.36, 2.75) have 3 times higher odds of being overweight or obese during pregnancy compared with women who are 20 years or younger. Based on a mother's race/ethnicity, the highest likelihood of a mother being overweight or obese during pregnancy was found in Hispanic (AOR=1.22, 95%CI=1.15, 1.30), Hawaiian/Pacific islander (AOR=1.21, 95% CI=0.64, 2.31), and non-Hispanic Black/African American (AOR=1.10, 95%CI=1.05, 1.15) compared to non-Hispanic white mothers.

Mothers who gained 25 to 35 lbs. (AOR=1.31, 95% CI=1.25, 1.36) during pregnancy were 1.3 times more likely to be obese during pregnancy, 36-45 lbs. (AOR=3.75, 95% CI=3.45, 4.07) was 4 times more likely to be obese, and whose who gained over 45 lbs. (AOR=20.69, 95% CI=16.95, 25.24) were 21 times more likely to be obese during pregnancy. The odds of being overweight/obese increased with weight gain during pregnancy demonstrating the dose-response effect.

Having a macrosomia baby is also strongly associated with obesity during pregnancy increasing the odds more than 3 times (AOR=3.13, 95%CI=2.73, 3.59) compared to having a normal-weight baby. The odds are also 2 times higher for mothers having a cesarian section (AOR=1.87, 95% CI=1.79, 1.95) delivery due to pregnancy BMI.

4.3.2 Gestational hypertension

Mothers with a pre-pregnancy BMI of overweight (> 25) were over 1.7 times more likely to develop gestational hypertension (AOR= 1.66,95% CI=1.57, 1.75) than mothers with a normal pre-pregnancy BMI. Additionally, mothers with a pre-pregnancy BMI of obese (>30) are 3 times more likely to develop GHT (AOR=2.81, 95% CI=2.68, 2.95) than mothers that are normal weight.

Further, mothers who gained more than 45 lbs. (AOR=1.46, 95% CI=1.38, 1.55) during pregnancy have a 1.5 higher chance of developing gestational hypertension compared to mothers who gained <24 lbs. Compared to white women, mothers who are Asian, (AOR=0.51 95% cI= 0.45, 0.57), multiracial AOR=0.80, 95% CI= 0.70, 0.91) and Hispanic descent AOR=0.58, 95% CI=0.54, 0.61) women have lower odds of developing GHT.

If a mother develops gestational hypertension (AOR=2.82 95% CI= 2.70, 2.95) she is nearly 3 times more likely to have a premature birth (gestational age before 37 weeks). Mothers who gave birth to a low-birth-weight baby (AOR=2.40, 95% CI=2.28, 2.52) were found to be nearly 2 1/2 times more likely to have had GHT during pregnancy, and mothers who delivered via the cesarian method (possibly they learned about it before actual delivery) are 2 times more likely to experience hypertension (AOR=1.77, 95% CI =1.71, 1.84).

4.3.3 Gestational Diabetes Mellitus

Odds are nearly 2 to 3 times higher for gestational diabetes mellitus (GDM) when the mother is overweight before pregnancy (AOR=1.71, 95% CI=1.61, 1.82) or obese (AOR=2.89, 95% CI=2.73, 3.05). Weight gain during pregnancy was highly significant in the development of GDM. Mothers who gained about 36-45+ lbs. (AOR=0.53, 95% CI= 0.49, 0.57) (AOR=0.56, 95% CI= 0.52, 0.61) were less likely to develop GDM than mothers who gained 25-35 lbs. (AOR=0.66, 95% CI=0.63, 0.70) during pregnancy. The likelihood of a mother developing

GDM during pregnancy increases by 2 to 5 times as age increases from 21 to over 35 compared to mothers who are 20 years or younger. The chance of a mother developing gestational diabetes is more than 2 times in Asian mothers (AOR=2.27, 95% CI=2.09, 2.46) and 13% higher odds if the mother is Black compared to white mothers.

Gestational diabetes increases the odds of premature birth nearly 1 ½ times (AOR=1.46 95% CI 1.38, 1.55) and macrosomia baby (AOR=1.35, 95% CI=1.24, 1.46); and nearly 2 times higher odds of mother having a cesarian section (AOR=1.77, 95% CI=1.49, 1.63).

CHAPTER V: DISCUSSION

This study investigated the association between pre-pregnancy BMI (as a primary risk factor) and pregnancy-associated conditions, (BMI during pregnancy, Gestational Hypertension, and Gestational Diabetes), birth outcomes (low birth weight, macrosomia, preterm birth, and c-section), among Georgia mothers. Data from the Georgia Natality and Birth Certificate database from 2022 was used to examine the outcomes and their suspected predictors. Current analysis has reinforced the relationship between preconception BMI, PACs, and birth outcomes. We directly associate specific maternal characteristics to PAC that could help further understand maternal health complications and mortality.

5.1 Pregnancy-associated conditions (PACs)

This study focused on the most common pregnancy-associated conditions (PACs) that are associated with maternal mortality. These conditions include having a higher BMI during pregnancy, gestational hypertension, and gestational diabetes, all increasing the likelihood of adverse birth outcomes. Birth outcomes were also affected by a mother's BMI before conception when all maternal characteristics were accounted for. Pre-pregnancy BMI was the main exposure of interest for pregnancy-associated conditions that can influence maternal and birth outcomes.

5.1.1 Body Mass Index (BMI) during Pregnancy

The prevalence of overweight (28.7%), and Obese (62.3%) seems to be high among pregnant Georgia mothers. Women who are overweight or obese before pregnancy are at a threefold increased risk of exceeding Gestational weight gain (GWG) guidelines compared to

those who are not (Siega-Riz et al., 2020). This current study established that mothers whose pre-pregnancy weight was overweight or obese would stay in this BMI during pregnancy, further risking maternal and prenatal health. Such maternal health risks include insulin resistance, miscarriage, and depression (Sunder et al., 2022).

The age of the mother was found to be a significant factor in body mass index during pregnancy. By the age of 35, the risk of a mother being overweight or obese is 2 times more likely to occur than in younger women. Additionally, the race/ethnicity of the mother was also an indicator for women with a high BMI during pregnancy. This includes women of Hispanic, Hawaiian/ Pacific Islander, and non-Hispanic Black/African American descent who had a higher chance of being overweight/obese than non-Hispanic White mothers. Previous research into race/ethnicity found that 3 to 15% of the association between race or Latina- ethnicity and severe maternal morbidity is mediated by pre-pregnancy obesity (Siddiqui et al., 2021). This disparity in Hispanic mothers could be a mark of systematic racism that could deter Spanish-speaking migrants and American-born Hispanics from important health information. Information that can include weight management methods before conception and the potential higher risk of negative birth outcomes for a higher pre-pregnancy BMI.

Weight gain during pregnancy was highly consistent with a higher BMI during pregnancy. Mothers who gained 25-35 lbs. during pregnancy only had 1.3 higher odds of being overweight/obese during their pregnancy. Between 36-45 lbs. the odds rise to 4, and 45+ lbs. are gained during pregnancy the odds rise to 21 times. Pregnancy weight gain guidelines show that women with a preconception BMI of under/normal are recommended to gain 25-40lbs, while overweight are recommended to gain no more than 15-25 lbs., and obese are recommended to gain no more than 11-20 lbs. (Mayo Clinic., 2022). These guidelines were set up as a function

for weight gain that is necessary during pregnancy for healthy fetal growth. They seek to outline minimum and maximum weight gained for mothers who are overweight and obese.

5.1.2 Gestational hypertension (GHT)

In this population-based cohort study, we found that the incidence of Gestational Hypertension in pregnant mothers in Georgia is 9.3%, lower than the national average of 13% in 2019 (CDC Press Release., 2022). The presence of GHT increases the risk of a mother's severe complications such as heart attack and stroke (Ford et al., 2022). Extensive research on gestational hypertension indicates that it is associated with a range of cardiovascular conditions later in life (Honigberg et al., 2019). In this study, gestational hypertension is shown to be affected by a mother's pre-pregnancy BMI and weight gain during pregnancy. GHT was found to have the most effect on premature birth, low birth weight, and delivery via c-section. This in turn can increase the risk of maternal complications. According to multivariate analysis on the likelihood of developing GHT mothers with a pre-pregnancy BMI of overweight or obese were found to be 2 to 3 times higher than mothers that are under/normal weight. These findings highlight potential interventions that seek to improve both physical and cardiovascular health.

Based on the age of the mother, we found that mothers between the ages 21-25 and 35+ are more likely to develop GHT than mothers between 26-35. Findings note that age is not an important factor in the development of GHT. Based on the race/ethnicity of the non-Hispanic Black/ African American, American Indian/Alaskan Native, and multiracial were more likely to develop gestational hypertension than non-Hispanic White mothers. The disparities can account for potential factors of systematic racism, food deserts, psychosocial stress, and financial insecurities that minority communities can encounter. (Ford et al., 2022; Tipton et al., 2020).

Gestational hypertension is 1.2 times more likely to occur for every 10 lbs. a mother gains during pregnancy. This corresponds with research findings that direct weight gain increases the risk of GHT and further impacts maternal and neonate health.

5.1.3 Gestational Diabetes Mellitus (GDM)

The incidence of Gestational Diabetes Mellitus in Georgia mothers was 6.7%. Nationally, the prevalence is about 6% to 9% of pregnant women develop gestational diabetes (Gregory et al., 2022). This current study is quite representative of nationwide rates of GDM. Pre-pregnancy BMI is a critical factor in the development of insulin resistance, type II diabetes, and GDM (Giannakou et al., 2019). Our research determined that mothers who were overweight or obese before conception are 2 to 3 times more likely to develop gestational diabetes than women who are underweight or normal weight. This exposure variable highlights the need for parenthood planning to incorporate fitness and healthier lifestyle habits to combat the development of this condition during pregnancy.

We also found that gestational diabetes increases as the age of the mother increases. It is suggested that screening for GDM in mothers over the age of 25 and that the United States should implement such guidelines to offset the complications that GDM causes (Li et al., 2020). The greatest odds of developing gestational diabetes have been observed in Asian mothers twice as much as in non-Hispanic white mothers. Interestingly, mothers of non-Hispanic Black/African Americans were amongst the lowest odds of developing GDM during pregnancy. These findings warrant more investigations of population-based studies on race/ethnicity in gestational diabetes mellitus. Previous findings do note that non-Hispanic Black/African American women are less likely to have GDM, even when they had worse birth outcomes than non-Hispanic White women

suggesting other factors are responsible for these disparities (Newman et al., 2022). Weight gain during pregnancy has no effect on the development of GDM.

5.2 Birth Outcomes

5.2.1 Premature Birth

The incidence of premature birth in Georgia was 11.9% in 2022. This study found that higher odds of premature birth were recorded in mothers who developed gestational hypertension and gestational diabetes mellitus. Neonates born prematurely are also at risk for developing hypertension and diabetes later in adulthood (Howson et al., 2013). Previous literature found that premature neonates were more likely to have serious health extensive health problems. Such issues include cerebral palsy, intellectual impairment, chronic lung disease, and vision impairment (Howson et al., 2013; Ward et al., 2003).

5.2.2 Birth weight

The incidence of an infant having a low birth weight was 10.6%. Low Birth weight (LBW) was found to have 1.5 higher odds of being affected by GHT. LBW was found to have lasting effects on an infant's health, increasing the overall risk of type II diabetes in adulthood (Martin-Calvo et al., 2021).

The incidence of having a macrosomic infant was 6%. Macrosomia was nearly 2 times more likely to develop in mothers with a pregnancy BMI of overweight or obese. A mother with gestational diabetes was found to have 1.2 odds of giving birth to a macrosomic infant. These odds were consistent with background research in which birth outcomes were determined by the

physical health of the mother before pregnancy, in which macrosomia can also be a factor (Hunt et al., 2012).

5.2.3 Caesarean Section

The prevalence of the population that had a cesarean section was 35.2%. Interestingly, among all PACs, a c-section was 2 times more likely to develop any of the three conditions. This type of delivery is another birth outcome that contributes to the outside influence on the health of a newborn, changing the immune response and even hormonal exposure when vaginal birth is no longer an option (Temmerman et al., 2021).

5.3 Strengths, Limitations, and Future Research

The strength of this study relies on a population-based cohort study where the temporality of exposure can be confirmed before outcomes of interest and expected. The study includes all mothers who gave birth in 2022 (N=129723) which enables us to obtain a complete picture of associated factors and account for incidence rates of PACs and birth outcomes. The larger the study sample size helps to keep the margin of error small and allows researchers to control the risk of reporting false-negative or false-positive findings. The sample size is important because larger samples offer more precise estimates of the true population value.

Another strength of this study is that it looks at multiple pregnancy-associated conditions and maternal characteristics to get a wider view of which conditions contribute to the birth outcomes, and who are most likely to be at risk further reinforcing previous background research.

The study has certain limitations that need to be noted. The data only included live births and the extent of negative outcomes in terms of fetal loss cannot be explained. The original data

included types of birth defects that were not specified correctly or had missing data and thus could not be included in the analyses. Research suggests that specific birth defects are strong predictors of stillbirth or fetal loss. This data would have painted a clearer picture of fetal mortality regarding PACs.

In terms of variable measurement, there is no clear documentation of when pre-pregnancy BMI, BMI during pregnancy, and weight gain during pregnancy were recorded in the data source. Pregnancy BMI and weight gain during pregnancy are likely dependent on the gestational weeks. While the large sample size is preferred, very large samples tend to transform small differences into statistically significant differences - even when they are clinically insignificant. As a result, both researchers and clinicians may be misguided, which may lead to failure in treatment decisions. Results from bivariate and multivariate analyses showed this trend of becoming a small difference significant. For example, a small percentage difference between the sub-groups achieved significance. A random controlled trial (RCT) may help reduce the occurrence of significant conditions with a small proportion of the population.

Future research should consider expanding utilizing rare conditions such as birth defects and fetal mortality to nail down significant associations with PACs. Also expanding PACs to include deep vein thrombosis (DVT), Anemia, and Peripartum Cardiomyopathy will provide a better overview of other conditions that put maternal health at risk during pregnancy. Expanding on maternal and fetal outcomes will allow future researchers and obstetrics to better shape medical responses and even screen for PACs after conception.

Future research should also consider the social economic constructs, and environmental factors that could hinder pre-pregnancy weight loss for expectant mothers. These constructs and factors encompass social, environmental, and financial resources, access to education, nutritional

information, the ability to discuss such topics with health professionals, and emotional barriers that make consistent weight loss difficult for many women (Vanstone et al., 2016). This can even be expanded with PACs, like GDM which can be impacted by food insecurity, another contextual aspect in the health of a pregnancy (Yong et al., 2021). Conducting a wide range of research focusing on the social and economic effects on maternal and prenatal health is useful for expanding health policy and institutional change that allows mothers to access the resources necessary for healthy prenatal care and eventual birth.

CHAPTER VI: CONCLUSIONS

In conclusion, pre-pregnancy BMI is a highly consistent potential risk factor for all pregnancy-associated conditions and plays a major role in the occurrence of negative birth outcomes. The effect of pre-pregnancy BMI on PACs should be addressed before conception and during prenatal care. Maintenance of healthy and sustainable weight loss before pregnancy can decrease the occurrence of both gestational hypertension and diabetes by 3-fold. Interventions such as increased physical activity and eating a balanced diet should be considered for pregnancy planning.

Macrosomia and delivery via c-section are birth outcomes that are consistent with having a high BMI during pregnancy. Other birth outcomes such as premature birth, low birth weight, and delivery via c-section are consistent outcomes associated with the development of gestational hypertension. Mothers who develop gestational diabetes are also more likely to have a premature birth, a macrosomic infant, and delivery via c-section. C-sections are found to be highly significant with all PACs, and the procedure should be further studied on ways to make the surgery safer for expectant mothers due to its substantial risk. This factor should be further considered in parenthood planning to match the screening standards of other high-income nations with lower maternal mortality rates.

This research also found persisting ethnic disparities in the development of PACs between mothers. Higher instances of mothers who are overweight/obese during pregnancy were found in Hispanic and Hawaiian/Pacific Islanders. Mothers who were more likely to develop gestational hypertension were Black/African American and American Indian/Alaskan Native. Mothers of Asian, Hawaiian/Pacific Islander, and American Indian/Alaskan Native descent were all more likely to develop gestational diabetes. Therefore, we found notable disparities unique to

each pregnancy-associated condition that should promote further research into each of these minority communities that may exacerbate negative birth outcomes.

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