2020

Differences in Induced Labor and Cesarean Section for Millennial and Generation-X Women

Emmanuel Lungu
Medical University of South Carolina

Differences in Induced Labor and Cesarean Section for Millennial and Generation-X Women

by

Emmanuel Lungu

A doctoral project submitted to the faculty of the Medical University of South Carolina

in partial fulfillment of the requirements for the degree

Doctor of Health Administration

in the College of Health Professions

Differences in Induced Labor and Cesarean Section for Millennial and Generation-X Women

by

Emmanuel Lungu

Approved by:

Chair, Project Committee	Kit N. Simpson, DrPH	Date
Member, Project Committee	Annie N. Simpson, Ph.D.	Date
Member, Project Committee	Elizabeth A. Brown, Ph.D.	Date

Acknowledgments

To God be the glory for giving me the strength to complete my program through the numerous challenges that I experienced, including the deaths of close family members: Grandma - B Zulu, father-Sylvester, sister -Thoko, cousins -Sharon, Mwansa, and George. I know you would all be proud of this day.

To my dear wife, Ingutu Mufana Lungu, thank you for standing by me throughout the program and for being a part of this journey. To my children, Felistus, M’khuzo, Tsepo, and Limpho, I know it has not been easy to accommodate my busy schedules, but through it all, I am grateful you all stood by me. I dedicate this accomplishment to you as an example to always aim high and never give up on your lifelong dreams.

To Dr. Kit Simpson, DrPH, my Committee Chair, thank you for believing in me and for your assistance with the research data, developing my methodology, and for assisting with the data analysis. Without your selfless support, this day would not have been possible. I will forever be indebted to you and look forward to working with you on some future research projects. To Dr. Annie N. Simpson, Ph.D., and Dr. Elizabeth A. Brown, Ph.D., thank you for accepting to be on my committee and for the valuable input that made my research richer. I also wish to express my gratitude to Marshall Chew, Faculty Research Associate, for assisting me with data analysis.

To the faculty and staff in the College of Health Professions- Health Administration, I wish to acknowledge your commitment to enhancing the quality of the DHA program. Specifically, I am grateful to Dr. Jillian Harvey, Ph.D. (DHA Program Director), for her professionalism and for giving me an opportunity and encouraging me to pursue the program after facing some challenges at another institution. To Rebecca (Becca) Barry and Leslie Anderson, DHA Program Coordinators, I thank you for your smiles and your commitment to our success. To Christine Andresen, Librarian, thank you for helping proofread my references.

I also wish to acknowledge the support of all my classmates: Richard (Rich) Bottner, Aretha Polite-Powers, Brian Wiggs, Codeitha Gaddist, Jeff Nwabeke, Jeff Souza, Jennifer Lai, Julie Baber, Lynn Carpenter, Max Saber, Mildred Scott, Nicole Miller, Reya Patel, Salman Moti, Wen Jan, and Tanya Seaton.

Finally, to my dear mom, Godfridah Lungu, a virtuous woman, and my most significant pillar of support through good and bad times. Thank you for your prayers and for pushing us to value education despite your humble upbringing and formal education. Thank you for pushing us to dream big.

Abstract of Dissertation Presented to the Medical University of South Carolina

In Partial Fulfillment of the Requirements for the

Degree of Doctor of Health Administration

Differences in Induced Labor and Cesarean Section for Millennial and Generation-X Women

by

Emmanuel Lungu

Chairperson: Kit N. Simpson, DrPH

Committee: Annie Simpson, Ph.D.

Committee: Elizabeth A. Brown, Ph.D.

Objective - To explore differences in cesarean delivery and induced labor between Generation X and Millennial women at the same age, 20-35

Method – A retrospective cohort study using the Nationwide Inpatient Sample (NIS) for the years 2001 and 2016. Women aged 20 to 35 in 2001(Generation X) and 2016 (Millennials) were included. OB outcome measures were compared at the same age to understand the trends in the interventions and the characteristics of women who receive them.

Results - Millennial women compared to Generation-X women were 32% (95% CI 1.31-1.33) more likely to have cesarean delivery, and 28 % (95% CI 1.27-1.29) more likely to have induced labor. Furthermore, Millennial women were more likely to be older, have higher comorbidities, severe maternal morbidity (SMM), and longer length of hospital stay.

Discussion –Millennial women have higher rates of cesarean delivery and induced labor even after controlling for age, race, and comorbidities. The results are an indication that obstetric interventions are routinely performed without medical indications.

Table of Contents

Acknowledgments *4*

1 CHAPTER 1 INTRODUCTION *10*

1.1 Background and Need **10**

1.2 Problem Statement **12**

1.3 Study Objective and Hypotheses **12**

1.4 Null Hypothesis **13**

1.5 Alternative Hypothesis **13**

1.6 Population and Analysis **13**

2 CHAPTER II: LITERATURE REVIEW *15*

2.1 Millennial Generation **16**

2.2 Maternal Mortality **18**

2.3 Maternal Mortality Trends **19**

2.4 Severe Maternal Morbidity **21**

2.5 Maternal Characteristics and Outcomes **22**

2.5.1 Race/Ethnicity 23

2.5.2 Maternal Age 24

2.5.3 Payer Type/Insurance Coverage 25

2.5.4 Other Social Determinants 25

2.6 Obstetric Interventions **26**

2.6.1 Induction of Labor (IOL) 26

2.6.2 IOL Indications 27

2.6.3 Guidelines for IOL 27

2.6.4 Elective IOL 28

2.6.5 Comparative Evidence of Induction of Labor vs. Expectant Management 28

2.6.6 Policies of routine Induction of Labor 30

2.7 Cesarean Delivery 31

2.7.1 Indications: 31

2.7.2 Complications and morbidity 31

2.8 Characteristics Associated with Cesarean Delivery 32

2.8.1 Age 32

2.8.2 Insurance Coverage 32

2.8.3 Race/Ethnicity 33

3 CHAPTER III METHODOLOGY 34

3.1 Research Design 34

3.2 Study Population 34

3.3 Data Source 34

3.4 Data Set Description 35

3.5 Independent and Dependent Variables 35

3.6 Covariates 36

3.7 Outcomes Variable 38

3.8 Data Analysis 39

3.9 Protection of Human Subjects/Ethical approval 39

4 CHAPTER IV: RESULTS 40

4.1 Differences by Cesarean Delivery 43

4.2 Differences by Induction of Labor 46

4.3 Differences by Induction and Cesarean Delivery 49

5 CHAPTER V: DISCUSSION 51

5.1 Discussion of Results 51

5.1.1 Differences in the presence of maternal risk factors 51

5.1.2 Differences in the use of cesarean delivery and induction of labor 53

5.1.3 Differences in adverse obstetrical outcomes defined by CDC indicators 54

5.1.4 Differences in length of stay (LOS), cost of admission (adjusted for inflation), and discharge destination. 55

5.2 Summary 56

5.3 Limitations/Future Studies 57

5.4 Conclusion 58

6 References 59

List of Tables

Table 1 Selected Characteristics Differences Between Millennials and Generation Xers ... 17

Table 2. Top 10 Causes of Maternal Mortality in the US 20

Table 3. 21 CDC indicators to identify severe maternal morbidity 22

Table 4 Outcomes of elective induction of labor vs. expectant management 29

Table 5. Policies of routine induction of labor and outcomes 30

Table 6. Demographics and study variables (weighted) stratified by birth generation. 42

Table 7. Sub-group analysis of generational demographic differences by Cesarean delivery 44

Table 8. Cesarean deliveries for Millennials vs. Gen-X controlling for age and race analysis of maximum likelihood estimates and odds ratio estimates – The SURVEYLOGISTIC procedure 45

Table 10. **Generational Demographic Differences by Induction Delivery** 47

Table 11. Induction Deliveries for Millennials vs. Gen-X controlling for age and race analysis of maximum likelihood estimates and odds ratio estimates – The SURVEYLOGISTIC procedure 48

Table 12. Analysis of demographic differences by Induction with Cesarean - delivery 50

1 CHAPTER 1 INTRODUCTION

1.1 Background ad Need

About 13 percent of the roughly 4 million births that occur each year in the US result in one or more significant complications (Glance et al., 2014). About 50,000 of the women admitted for child delivery in the US experience SMM each year (Leonard, Main, & Carmichael, 2019; Petersen, Davis, Goodman, Cox, Syverson, et al., 2019). SMM is defined as life-threatening childbirth complications, including maternal hemorrhage, acute congestive heart failure, cardiac arrest, and acute myocardial infarction (Gao et al., 2019; Glance et al., 2014; Leonard, Main, & Carmichael, 2019; Centers for disease control and prevention, 2020, January 31). The rates of maternal mortality and adverse maternal outcomes among US women are the highest compared to women in other high-income countries despite the US spending more on healthcare than all other developed countries (Gunja et al., 2018). The cost of delivery with SMM diagnosis in the US is 2.1 times higher than delivery without any SMM diagnosis, $11,000 versus $4,300 (Chen et al., 2018).

Despite substantial improvements in evidence-based practices, extreme variability exists across hospitals, races, and socioeconomic strata despite significant advances in evidence-based practices (EBP) known to improve maternal outcomes (Glance et al., 2014). Specifically, racial/ethnic disparities exist in SMM with non-Hispanic black women being three-five times at a higher risk of maternal death and severe maternal morbidity than non-Hispanic white women even after controlling for individual and hospital risk factors (Howell et al., 2018; Leonard, Main, Scott, et al., 2019; Petersen, Davis, Goodman, Cox, Syverson, et al., 2019).

The reasons for the increase and variations in SMM are not clear. Still, a growing body of literature attributes it to the changes in the maternal characteristics over the past few decades, including increases in advanced maternal age (35 and above), obesity, comorbidities (pre-existing conditions), and obstetric interventions (specifically cesarean delivery) (Leonard, Main, & Carmichael, 2019). The rising rates of SMM and the documented racial disparities in maternal outcomes show the need to identify tractable delivery processes affecting the quality of maternal care provided and outcomes.

One critical strategy to improve outcomes is to understand the trends in obstetric interventions intended to improve outcomes and the characteristics of women who receive them.

Millennial women (born between 1981 and 1996) account for 82 percent of all US childbirths in the US (Dimock, 2019; Livingston, 2018), yet detailed analyses of their maternal (OB) characteristics, obstetric interventions, and health outcome differences from the previous generational cohorts is lacking. Literature suggests significant differences in generational-cohorts experiences may influence health expectations and preferences, which may influence health outcomes (DePew, 2019; Lloyd et al., 2013).

To the best of our knowledge, literature is limited that compares generational-specific health outcomes. Our literature review identified one study by DePew (2019) that examined health outcome differences (self-reported mental, physical, and functional status) between Millennials and Generation X by using the data from the National Health Interview Survey (NHIS). However, the study did not specifically examine women or maternal outcomes.

The primary objective of this study is to compare obstetric outcomes and the use of cesarean delivery and induction of labor for Millennial (born 1981-1996) and Generation X women (born 1965-1980) at the same age (20-35) to understand the trends in the interventions and the characteristics of women who receive them.

Without fully understanding the maternal health characteristics and outcomes of specific populations, it is challenging to plan and prioritize resources necessary to improve maternal outcomes.

1.2 Problem Statement

Severe maternal morbidity has increased by more than 200%, primarily driven by maternal hemorrhage, from 49.5 in 1993 to 144.0 in 2014 (Centers for disease control and prevention, 2020, January 31). During this same period, between 1990 and 2015, cesarean delivery and induction of labor increased by 41% and 159%, respectively (Teitler et al., 2019).

Studies show no evidence of increased use of cesarean delivery or induction of labor and decreased maternal and neonatal morbidity (Hamilton et al., 2013; Martin et al., 2019). The trend may signify a possible increase in the number of cesarean deliveries and induced labor performed without any medical indication. Our study will compare maternal outcome measures to understand trends in the interventions and the characteristics of women who receive them.

1.3 Study Objective and Hypotheses

The primary objective of the study is to describe differences in risk (chronic health condition), OB process (use of cesarean and induction of labor), and outcomes for Millennial and Gen-X women in the same age span (20-35 years). Outcomes to be assessed include:

- Differences in the presence of maternal risk factors
- Differences in the use of cesarean delivery and induction of labor
- Differences of adverse obstetrical outcomes defined by CDC indicators

- Variations in length of stay (LOS), cost of admission (adjusted for inflation), and discharge destination.

1.4 Null Hypothesis

There are no differences in maternal risk factors, uses of cesarean sections and induction of labor, morbidity (defined by CDC indicators), length of stay, and cost of admission (adjusted for inflation) between Millennial and Generation X women at the same age (20-35).

1.5 Alternative Hypothesis

Millennial women compared to Generation X women at the same age (20-35) have higher maternal risk factors, use of cesarean delivery and induced labor, morbidity (defined by CDC indicators), hospital length of stay, and total cost of admission (adjusted for inflation).

1.6 Population and Analysis

The study population was drawn from the Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project (HCUP) databases, outsourced from the Medical University of South Carolina Research Center. The NIS is an all-payer nation-wide database that contains a 20% sample of all hospitalizations in the US. The sample included all women aged 20-35 in 2001 and 2016 who had child delivery hospitalizations, regardless of the outcome. Deliveries for women under 20 years old and over 35 years-old will be excluded because both maternal age extremes are independent risk factors for adverse maternal outcomes (Walker et al., 2020).

The SAS version 9.4 analytical software was used to analyze the data to compare sociodemographic, preexisting medical conditions, indications, and outcomes of IOL and cesarean delivery. Descriptive statistics tools were used to summarize the data, including frequency, percentage, mean, odds ratio, standard deviation, and cross-tabulations, to examine differences between group variables.

All continuous variables were tested by Wilcoxon- Mann-U test. Categorical variables were tested using the Chi-square to explore the significance of any variations in results. The Charlson Comorbidity Index was used to categorize and compare patients' comorbidities and clinical variables.

2 CHAPTER II: LITERATURE REVIEW

The US has the highest rate of severe maternal morbidity (SMM) and maternal deaths from pregnancy complications among developed countries (Callaghan et al., 2012; Collier & Molina, 2019; Gunja et al., 2018; Wang et al., 2020). SMM comprises life-threatening conditions, including acute myocardial infarction, cardiac arrest, or sepsis/shock, which if not quickly identified and treated may result in maternal death (Firoz et al., 2013; Gao et al., 2019; Geller et al., 2002; Gunja et al., 2018; Wilson & Salihu, 2007).

SMM increased by more than 200% in 10 years, from 49.5 in 1993 to 144.0 in 2014, driven by a substantial increase in blood transfusion between 1993 and 2014, from 24.5 in 1993 to 122.3 in 2014 (Centers for disease control and prevention, 2020, January 31). Without blood transfusions, the rate of SMM increased by about 20% from 28.6 in 1993 to 35.0 in 2014 (Centers for disease control and prevention, 2020, January 31).

Significant racial/ethnic disparities in pregnancy outcomes exist, with non-Hispanic black women having a 4-5 times higher prevalence of SMM than non-Hispanic white women even after controlling for individual comorbidity factors (Leonard, Main, Scott, et al., 2019).
The reasons for the rise and racial disparities have not been fully explored (Metcalfe et al., 2018). A growing body of evidence points to the changes in the risk profiles of women becoming pregnant, including delayed motherhood, increases in obesity, chronic diseases (hypertension, diabetes, and heart diseases), and rates of cesarean deliveries (Gunja et al., 2018; King, 2012).

As the Millennial generation women (those born between 1981-1996) now account for the vast majority of all US childbirths (Livingston, 2018; White &Wurn, 2009), there is an urgent need to explore maternal health characteristics specific to this generation to recognize potential trends and opportunities for improvement.

This literature review uses multiple sources to provide an overview of the current evidence on the characteristics of pregnant women that are associated with pregnancy-related adverse outcomes and interventions.

2.1 Millennial Generation

The Millennial generation, also known as Generation Y (Gen Y) or Millennials, comprises those born between 1981 and 1996 (Dimock, 2019). They come after Generation X (those born between 1965 and 1980). Millennials number approximately 73 million compared to Boomers (71.6 million) and Generation X (65.2) million "American Community Survey: 2009-2013."; Fry, April 28, 2020).

Millennials are different from other generations in so many ways. Some of the differences in the characteristics of Millennials and Generation X are listed in table 1 below. The differences between generations give us a unique view of how generational life experiences influence specific behaviors.

Millennials are more educated and racially/ethnically diverse than previous generations, with 44.2 percent belonging to a minority race or ethnic group and highly educated (US Bureau of Census, July 25, 2015). DePew (2019) found 31.9% of Millennials have a bachelor's degree compared to 23.4% of Generation X.

Similarly, a US Census Bureau survey found 22 percent of Millennials (18-34 years) have a college degree compared to 16 percent for Generation X, one in four Millennials (17.9 million) speaks a foreign language at home, one in five (13.5 million) millennials live in poverty compared to 8.4 million Generation X, and about three in 10 Millennials were marries compared to six in 10 Generation X ("American Community Survey: 2009-2013.")

Millennials are the first generation to grow up in an environment with rapid growth in digital information technology and social media, providing them with easy access to health information (Lloyd et al., 2013). It is unclear how Millennials' greater access to digital technology and health information influences their health care preferences and health outcomes. However, literature shows an association between greater access to digital technology with sedentary lifestyles, feelings of social isolation, anxiety, and depression among Millennials (DePew, 2019).

Table 1 Selected Characteristics Differences Between Millennials and Generation Xers

Characteristic	**Millennials** **Born 1981-1996**	**Generation X** **Born 1965-1980**
Total population (Fry, 2020)	~73 million	~65 MILLION
Education attainment ≥ Bachelor's Degree (DePew, 2019) (Age 20-35 years)	31.9%	23.4%
Health insurance status (DePew, 2019) (Age 20-35 years)	13.5% uninsured 18.9 public insurance 64.0% Private insurance	23.2% uninsured 5.8% of public insurance 69.0% Private insurance
Already mom at the age of 20 to 35 (White &Wurn, 2009).	48 percent (in 2016) – Delaying motherhood.	57 percent (in 2000)
Marital Status ("American Community Survey: 2009-2013.")	3/10 married between 18-34 years	6/10 married between 18-34 years.

Millennials are also changing the way health care is delivered. The vast majority of millennials prefer "on-demand" health care delivery options like Urgent Cares, clinics, and telemedicine rather than going to a primary care physician for their health care (Milne, 2019). About 50% of Millennials,18-29-year-old, report not having a primary care physician to manage their health care needs, raising concerns about potential delays in catching severe medical problems before they become critical (Milne, 2019). A growing body of evidence now shows millennials are in poorer health than previous generations, with their health declining faster than previous generations (White &Wurn, 2019).

Millennials have a higher prevalence of hypertension, high cholesterol, tobacco use disorder, and behavioral health problems (major depression and hyperactivity) than previous generations (White &Wurn, 2019). Millennials' maternal health patterns reveal a worrisome trend of delayed motherhood, with the mean average age at first pregnancy of 26.3 (rising from 24.9 years in 2000 to 26.3 years in 2014) (Mathews & Hamilton, 2016).

Only 48 percent of Millennials at the age of 20 to 35 in 2016 were already moms compared to 57 percent of Generation X women (those born between 1965 and 1980) who were already moms at the same age in 2000 (Mathews & Hamilton, 2016).

The combination of poor health characteristics and delayed motherhood for Millennials raises concerns about worsening maternal health outcomes, as advanced maternal age and poor maternal characteristics are associated with increased risk of adverse maternal outcomes (Kortekaas et al., 2020; Lipkind et al., 2019).

2.2 Maternal Mortality

Maternal mortality is any death of a woman (other than accidental) that occurs while a woman is still pregnant or within 42 days of the end of pregnancy, regardless of the duration or site of the pregnant occur during pregnancy (Centers for disease control and prevention, 2020, February 20).

Pregnancy-related death is any death of a woman (other than accidental) that occurs while the woman is pregnant or within one year of the end of pregnancy, regardless of the duration or site of the pregnancy (Centers for disease control and prevention, 2020, February 20).

In the US, the CDC is the primary source of maternal death/mortality data. The data is housed in the two national systems, the National Vital Statistics System (NVSS) and the Pregnancy Mortality Surveillance System (PMSS) (Collier & Molina, 2019). All 50 states, including the District of Columbia and New York City, voluntarily submit maternal death certificates linked with fetal birth or death certificates for all pregnant women who died while pregnant or within a year of termination of pregnancy (Chang et al., 2003; Creanga et al., 2017; Petersen, Davis, Goodman, Cox, Mayes, et al., 2019).

Epidemiologists then analyze the data to determine the cause and timing of death, which is then used to generate pregnancy-related mortality surveillance reports. For this study, pregnancy-related death, maternal mortality, and maternal death will be used synonymously.

2.3 Maternal Mortality Trends

Between 1987 and 2017, the maternal mortality ratio (defined as deaths per 100,000 livebirth deliveries) in the US more than doubled - from 7.2 deaths per 100,000 live births in 1987 to about 17.2 deaths per 100,000 live births in 2015 (Hoyert, 2007; (Petersen, Davis, Goodman, Cox, Mayes, et al., 2019). Literature credits the implementation of the Pregnancy Mortality Surveillance System (PMSS) in 1986 to the improved identification of maternal deaths and the collection of information about the causes and risk factors associated with maternal mortality (Petersen, Davis, Goodman, Cox, Mayes, et al., 2019).

Table 2 list the top 10 leading causes of maternal deaths, based on the CDC criteria, which include cardiovascular diseases, non-cardiovascular medical conditions, infection

(12.5%), cardiomyopathy (11.0%), and hemorrhage (11.0%), (Centers for disease control and prevention, 2020, February 20).

Table 2. Top 10 Causes of Maternal Mortality in the US

Cause of Maternal Mortality	**Rate (%)**
Cardiovascular diseases	15.7%
Non-cardiovascular medical conditions	13.9%
Infection	12.5%
Cardiomyopathy	11.0%
Hemorrhage	11.0%
Thrombotic pulmonary/embolism	9.0%
Cerebrovascular accidents	7.7%
Hypertensive disorders of pregnancy	6.9%
Unknown	6.4%
Amniotic fluid embolism	5.6%

The timing of maternal deaths varies, with 31.3% of the maternal mortality occurring during pregnancy, 16.9% during delivery, 18.6% 1-6 days after delivery, 21.4% 7-42 days after delivery, and 11.7% 43-365 days after delivery (Petersen, Davis, Goodman, Cox, Mayes, et al., 2019). Maternal hemorrhage and amniotic fluid embolism cause the most deaths at delivery, high blood pressure disorders, postpartum hemorrhage, and infection cause the most death from postnatal day 1 to one week postpartum, and cardiomyopathy and cardiovascular disease are the leading causes of maternal death from1 week to 1 year postpartum (Centers for disease control and prevention, 2020, May).

Growing evidence shows that 60 percent of all maternal deaths are preventable ("Pregnancy-related deaths," 2020). Multiple factors contribute to maternal mortality, including patient, provider, or system-related (Petersen, Davis, Goodman, Cox, Mayes, et al., 2019).

2.4 Severe Maternal Morbidity

In addition to increased maternal deaths, the US is experiencing increased rates of SMM (defined as unexpected pregnancy outcomes that negatively impact the woman's health long or short term) (Firoz et al., 2013). Severe maternal morbidity is 50 to 100 times more prevalent than maternal death, and disproportionately affect minority women in the United States (Liese et al., 2019).

Between 1993 - 2014, severe maternal morbidity increased by 200% (driven by maternal hemorrhage), from 49.5 in 1993 to 144.0 in 2014 (Centers for disease control and prevention, 2020, January 31). After excluding blood transfusion, the increase was 20% over time from 28.6 in 1993 to 35.0 in 2014 (Centers for disease control and prevention, 2020, January 31). SMM related to hemorrhage increased by 399%, acute renal failure 300%, adult respiratory distress syndrome 205%, cardiac arrest, fibrillation, or conversion of cardiac rhythm by 175%, shock at 173%, acute myocardial infarction or aneurysm 100%, ventilation/temporary tracheostomy at 93%, Sepsis at 75%, and hysterectomy at 55 (Centers for disease control and prevention, 2020, January 31).

Despite SMM being 50 to 100 times more prevalent than maternal death, it is not routinely studies leading to a lack of better understanding of the specific causes. The CDC

(2020) currently uses 21 (Table 3) indicators to identify and track SMM. If not quickly identified and treated, these conditions may result in maternal death (Firoz et al., 2013; Gao et al., 2019; Geller et al., 2002; Gunja et al., 2018; Wilson & Salihu, 2007).

Table 3. 21 CDC indicators to identify severe maternal morbidity

Acute myocardial infarction	Aneurysm	Acute renal failure
Adult respiratory distress syndrome	Amniotic fluid embolism	Cardiac arrest/ventricular fibrillation
Conversion of cardiac rhythm	Disseminated intravascular coagulation (DIC)	Eclampsia
Heart failure/arrest during surgery or procedure	Puerperal cerebrovascular disorders	Pulmonary edema / acute heart failure
Severe anesthesia complications	Sepsis	Shock
Sickle cell disease with crisis	Air and thrombotic embolism	Blood products transfusion
Hysterectomy	Temporary tracheostomy	Ventilation

2.5 Maternal Characteristics and Outcomes

Maternal mortality and morbidity vary substantially by race/ethnicity, maternal age, education, income, geographic location, hospital type, and pre-existing chronic conditions (Howland et al., 2019; Leonard, Main, Scott, et al., 2019; Liese et al., 2019; Main et al., 2020; Metcalfe et al., 2018; Petersen, Davis, Goodman, Cox, Syverson, et al., 2019). The involvement of multiple factors causing SMM provides valuable insight into the complexity of preventing severe maternal morbidity and mortality in the US.

2.5.1 Race/Ethnicity

The trend in the increase in maternal mortality and morbidity in the US over the past three decades has not been consistent across all racial groups (Metcalfe et al., 2018). Racial and ethnic minority groups have consistently been associated with higher maternal mortality and morbidity rates than non-Hispanic white women, raising concerns about variations in care related to structural racism (Chang et al., 2003; Fingar et al., 2006; Howland et al., 2019; Leonard, Main, Scott, et al., 2019; Liese et al., 2019; Wang et al., 2020). The disparities in maternal outcomes are more significant on non-Hispanic black women even after controlling for all other factors.

Literature shows that non-Hispanic black women fare poorly in all SMM indicators used by the CDC to measure outcomes, including rates of blood transfusion, DIC, heart failure, hysterectomy, acute respiratory distress syndrome, ventilation, acute renal failure, eclampsia, shock, and sepsis even after adjusting for confounders (Admon et al., 2018; Fingar et al., 2006; Liese et al., 2019)

Similarly, maternal mortality for non-Hispanic black women is consistently ranked higher (three-to-four times) than that for non-Hispanic white women even after controlling for comorbidities or chronic medical conditions (Admon et al., 2018; Berg et al., 1996; Berg et al., 2010; Chang et al., 2003; Creanga et al., 2015; Mogos et al., 2020; Petersen, Davis, Goodman, Cox, Syverson, et al., 2019).

The most common underlying causes of maternal mortality among non-Hispanic black women include preeclampsia, eclampsia, and embolism (Collier & Molina, 2019). Preeclampsia is a potentially fatal maternal condition marked by the new onset of high blood pressure after 20 weeks' gestation, accompanied by proteinuria or significant end-organ dysfunction, whereas eclampsia encompasses pregnancy-induced hypertension with the development of grand mal seizures (Bernardes et al., 2019; Dekker, 2014; Haroon et al., 2019; Heard et al., 2004; Wen et al., 2019).

Non-Hispanic black women are at a higher risk of ectopic pregnancy (8%) than white women (4%) (Chang et al., 2003), and are six times more likely to die from cardiomyopathy and complications of anesthesia (Berg et al., 1996; Chang et al., 2003).

The variability in outcomes by race is further proof that more can be done to narrow the gap and improve outcomes for all women.

2.5.2 Maternal Age

Similar to race, maternal age has consistently been found to be an independent risk factor for adverse maternal outcomes, including gestational diabetes, preeclampsia, placenta previa, low birth weight (less than 2500 g), and preterm births (Cavazos-Rehg et al., 2015; Walker et al., 2020).

Between 2000 and 2017, the rate of women under 25-years-old giving birth declined, whereas those above 25 years old have increased (Anne et al.). There has been an increase in the percentage of births from women aged 25-29 (26.8% to 29.1%), women aged 30–34 (22.9% to 28.3%), and women aged 35–39 (11.1% to 14.4%) (Anne et al.).

Advanced maternal age (35 years and above) is associated with higher obstetric intervention rates, increases in hypertensive disorders, placenta abruption, and perinatal death even after controlling for other patient and non-patient factors (Dublin et al., 2014; Kean et al., 2020).

Maternal age distribution affects the outcomes of the same conditions differently. Walker et al. (2020) compared the results of women under 20 years old with those between 35-39 years old. They found women under 20 years-old with diabetes mellitus experienced higher rates of preeclampsia, large for gestation babies, and lower rates of cesarean delivery. In contrast, women aged 35-39 years with diabetes experienced higher rates of intrauterine fetal demise (IUFD), cesarean births, and lower rates of large for gestation babies (Walker et al., 2020).

2.5.3 Payer Type/Insurance Coverage

The association between insurance type or coverage with maternal outcomes has been widely researched. A systematic review by Wang et al.,(2020) found 21 studies, which found insurance coverage was a predictor of maternal outcomes with better results associated with private/commercial insurance coverage. In contrast, women with Medicaid or no insurance coverage were at a higher risk for adverse maternal outcomes, including deaths from cardiovascular, respiratory, and sepsis-related conditions (Wang et al., 2020).

2.5.4 Other Social Determinants

Several other social determinants affect maternal outcomes. For example, women with lower levels of education, low income, unmarried, and those admitted to urban teaching hospitals, or living in the Southern states are associated with a higher risk of maternal mortality and morbidity (Acosta et al., 2013; Collier & Molina, 2019; Goffman et al., 2007; Kozhimannil et al., 2019; Kuriya et al., 2016). Evidence, however, shows that the risks for non-Hispanic black women are not mitigated by education

2.6 Obstetric Interventions

The prevalence of adverse obstetric outcomes varies by timing relative to the end of pregnancy, with most complications occurring towards the end of pregnancy ("Levels of Maternal Care: Obstetric Care Consensus No, 9 Summary," 2019; Middleton et al., 2018).

Obstetric interventions to prevent adverse outcomes towards the end of pregnancy include practices of planned delivery by induction of labor (artificial stimulation of labor before the natural onset) and Cesarean delivery (Ananth et al., 2013; Loktionov et al., 2019; Marconi, 2019; Tsakiridis et al., 2020). Induction of labor and cesarean delivery accounts for more than 25% of all US births (Ananth et al., 2013; Obstetrics, 2009; Teitler et al., 2019).

Between 1990 and 2015, cesarean deliveries and labor induction increased substantially in full term-pregnancies by 41% and 159%, respectively (Teitler et al., 2019). While both cesarean delivery and induction of labor were previously performed for medical reasons, the practices are now routinely performed without any medical indications raising concerns about their contribution to a rise in SMM (Ananth et al., 2013; Marconi, 2019; Souter et al., 2019).

2.6.1 Induction of Labor (IOL)

IOL is the artificial stimulation of uterine contractions before the spontaneous or natural onset of labor (Hersh, Skeith, Sargent, & Caughey, 2019). IOL has been on the rise in the US since the 1990s, and nearly tripled between 1990 and 2018, from 9.5 percent in 1990 to 27.1 percent in 2018 (Martin et al., 2019)).

There are ongoing controversies regarding the association between IOL and increased rates of cesarean delivery, which stem from observation studies that erroneously compared outcomes of induction of labor with spontaneous delivery, instead of IOL versus expectant management (Caughey et al., 2009). These controversies are widely documented elsewhere (Marconi, 2019) and will not be the focus of this review.

However, overwhelming consensus exists regarding the benefits of IOL when expectant management possess a higher risk to maternal and fetal outcomes than to early termination of pregnancy via IOL (Ananth, Wilcox, & Gyamfi-Bannerman, 2013; Wilson, 2007).

2.6.2 IOL Indications

The top five indications of labor induction included gestation age greater or equal 41 completed weeks (23.2%), premature rupture of membranes (18.1%), gestation hypertension or preeclampsia (19.2%), diabetes (pre-existing or gestation) (10.0%), and oligohydramnios (low amniotic fluid volume) (7.0%) (Dublin et al., 2014).

2.6.3 Guidelines for IOL

The leading maternal health professional societies, the American College of Obstetricians and Gynecologists (ACOG), the Society of Obstetricians and Gynecologists of Canada (SOGC), the National Institute for Health and Care Excellence (NICE), and the World Health Organization (WHO) all have different guidelines for IOL to guide providers (Tsakiridis et al., 2020).

The ACOG indications of IOL include placenta abruption, chorioamnionitis, gestational hypertension, preeclampsia, eclampsia, post-term pregnancy, premature rupture of membranes, maternal medical conditions, fetal compromise, fetal demise, and logistic reasons at term such as distance from the hospital (Tsakiridis et al., 2020).

2.6.4 Elective IOL

Induction of labor is now increasingly performed without clinical indications, especially among term primiparas women delivering singleton infants (Ananth et al., 2013). IOL is not recommended before 39 weeks because it is associated with adverse maternal outcomes (Sgayer & Frank Wolf, 2019). The factors associated with elective IOL, include patient and provider convenience, external pressure or influence (peers), financial incentives, and technology (Moore & Low, 2012).

2.6.5 Comparative Evidence of Induction of Labor vs. Expectant Management

The timing of delivery is critical to preventing perinatal complications and maternal morbidity (Lee et al., 2016). To mitigate for adverse outcomes associated with advanced gestational age and variations in maternal care, health experts are increasingly pushing for widespread adoptions of policies that support routine induction of labor at term gestation and beyond (Akinsipe et al., 2012; Levine et al., 2019). Several studies now attribute IOL in low-risk singleton pregnancies at term and beyond with decreased risks of cesarean delivery or perinatal adverse events, and reduced risk of gestational hypertensive diseases (Caughey et al., 2009; Saccone et al., 2019; Sotiriadis et al., 2019).

Elective induction of labor, when compared to expectant management, reveals improved outcomes (Table 4). Elective induction is associated with decreased pregnancy-related hypertension in nulliparous (2.2% vs. 7.3%) and multiparous women (0.9% vs. 3.5%) (Souter et al., 2019) and less frequent severe maternal morbid (5.6% vs. 7.6%), less common cesarean delivery (35.9% vs. 41.0%), and less neonatal intensive care unit admission (7.9% vs. 10.1%) in obese women (Gibbs Pickens et al., 2018).

Table 4 Outcomes of elective induction of labor vs. expectant management

Study/Title	**Population**	**Design**	**Findings/Conclusion**
(Souter et al., 2019) Maternal and newborn outcomes with elective induction of labor at term	Singleton cephalic hospital births at 39+0-42+6 weeks gestation	Compares outcomes for electively induced births at ≥39 weeks' gestation with expectant management using abstracted chart data from 21 hospitals in Northwest U.S., January 1, 2012 – December 31, 2017, N = 55,694	Elective induction is associated with a decreased risk of cesarean delivery (14.7% vs. 23.2%). Elective induction is associated with decreased pregnancy-related hypertension in nulliparous (2.2% vs. 7.3%) and multiparous women (0.9% vs. 3.5%
(Gibbs Pickens et al., 2018) Term elective induction of labor and pregnancy outcomes among obese women and their offspring	Singleton, cephalic, nonanomalous deliveries to obese women gestational week (39-41), N = 165,975	Retrospective cohort study, 2007-2011, of California linked patient discharged data compared term-elective induction of labor between 39 - 41 weeks of gestation and pregnancy outcomes among obese women.	Elective labor induction after 39 weeks of gestation was associated with reduced adverse outcomes among obese women. Induced obese nulliparous women had less frequent severe maternal morbid, 5.6% vs. 7.6%; less common cesarean delivery, 35.9% vs. 41.0%, less neonatal intensive care unit admission, 7.9% vs. 10.1%.
(Grobman & Caughey, 2019; Grobman et al., 2018) Labor Induction versus Expectant Management in Low-Risk Nulliparous Women	Women at 38 weeks 0 days to 38 weeks 6 days of gestation to labor induction at 39 weeks 0 days to 39 weeks 4 days or expectant management	Multicenter randomized trial of labor induction in low-risk nulliparous women. N= 3062 women assigned to induction of labor; N=3044 to expectant management	Induction of labor at 39 weeks resulted in significantly lower rates of cesarean delivery, and similar or slightly better outcomes.
(Darney et al., 2013) Elective induction of labor at term compared with expectant management: maternal and neonatal outcomes.	All deliveries at 37-40 weeks without prior cesarean delivery in California, 2006.	A retrospective cohort study. Compared elective induction at each term gestational age (37-40 weeks) with expectant management using 2006 California Department of Health Service linked birth data. N= 362,154.	Elective induction was associated with decreased odds of cesarean delivery across all gestation ages and parity (37-40 weeks, OR 0.44, 0.43, OR 0.46, and 0.57, respectively.)
(Stock et al., 2012) Outcomes of elective induction of labor compared with expectant management: a population-based study.	Women with singleton pregnancies at 37 weeks or more gestation	Retrospective cohort study compared maternal and neonatal outcomes in pregnancies of 37 weeks or more. N=1,271,549.	Elective induction of labor at each gestation week is associated with decreased risk of perinatal mortality compared to expectant management in women with singleton pregnancies.

2.6.6 Policies of routine Induction of Labor

Multiple studies, as illustrated in Table 5, have linked routine induction of labor with fewer perinatal deaths, reduced cesarean deliveries, lower NICU admissions, and fewer babies with low Apgar scores (Cluver et al., 2017; Loktionov et al., 2019; Marrs et al., 2019; Middleton et al., 2018). Our study will explore the women characteristics associated with this potentially lifesaving intervention.

Table 5. Policies of routine induction of labor and outcomes

Study/Title	**Population**	**Design**	**Findings/Conclusion**
(Loktionov et al., 2019) Does an elective induction policy negatively impact on vaginal delivery rates?	A retrospective review of women undergoing induction of labor	Assess the influence of a policy of routine induction of labor on cesarean delivery rates and vaginal delivery. N=583	There was no association between elective induction of labor and increased risk of cesarean delivery or operative vaginal delivery in patients less than 35 years of age. Statistically difference in operative vaginal delivery vs. vaginal delivery existed between women ≥ 35-year-old and < 35-year-old groups.
(Middleton et al., 2018) Induction of labor for improving birth outcomes for women at or beyond- term	30 Randomized controlled trials in pregnant women at or beyond-term.	Assessed the effects of a policy of labor induction versus expectant management. N = 12,479 women.	A policy of labor induction is associated with fewer perinatal deaths, reduced cesarean deliveries, lower NICU admissions, fewer babies with low Apgar scores, but with more operative vaginal births.
(Cluver et al., 2017) Planned early delivery versus expectant management for hypertensive disorders from 34 weeks' gestation to term	Five Randomized trials of policies of planned early delivery for women with hypertensive disorders from 34 weeks' gestation.	Cochrane systematic review: Assessment of the benefits and risks of a policy of elective induction of labor versus a policy of expectant management. N=1,819.	Induction of labor after 34 weeks is associated with decreased risk of composite maternal morbidity and mortality in women with gestational hypertension/mild preeclampsia and no significant difference in neonatal outcomes.

2.7 Cesarean Delivery

Cesarean delivery (Cesarean section or Cesarean birth) is a common obstetrical intervention that has been rising worldwide since the 1990s and now accounts for one-third of all the births in the US (Martin et al., 2019). Significant variation exists in the rate of cesarean by across states, hospitals, and among low-risk women (Gynecologists & Medicine, 2014).

2.7.1 Indications:

Cesarean delivery is either medically indicated or electively indicated related to the maternal request or provider preference. The top three indications of primary cesarean delivery account for 80 percent of the deliveries. These reasons include labor arrest (failure to progress), nonreassuring fetal heart tracing, and fetal malpresentation (Boyle et al., 2013). Additional indications of cesarean delivery include uterine rupture, placenta previa, placenta accreta, umbilical cord prolapse, chorioamnionitis (maternal infection), suspected macrosomia, a prior cesarean delivery (Gynecologists & Medicine, 2014).

2.7.2 Complications and morbidity

While cesarean delivery can be lifesaving in certain instances, evidence shows that cesarean delivery in low-risk pregnancies is a risk factor for severe maternal morbidly (Clark et al., 2008; Leonard, Main, & Carmichael, 2019). Further, evidence reveals the increase in obstetric interventions shows no corresponding evidence of decreasing maternal and neonatal morbidity (Hamilton et al., 2013; Martin et al., 2019).

The risk factors for cesarean delivery morbidity include maternal age >30 years, minority race/ethnicity, the existence of pre-existing medical conditions, and type of delivery hospital (urban, teaching, or larger hospitals) (Creanga et al., 2015). Also, emergent cesarean deliveries are associated with higher risks of maternal and neonatal morbidity.

2.8 Characteristics Associated with Cesarean Delivery

2.8.1 Age

Advanced maternal age is linked to increased pre-pregnancy risk factors that may impact pregnancy outcomes and increase the risk of cesarean delivery. A large Danish population-based study (Rydahl et al., 2019) examined the association between advanced maternal age and risk for the cesarean section using maternal age less than 30 years as a reference and found a strong positive association between age and cesarean delivery. Nulliparous women aged 35-39 had twice the risk, whereas those over 40 years had triple the threat for cesarean delivery (Rydahl et al., 2019).

2.8.2 Insurance Coverage

A systematic review and meta-analysis of 16 studies involving about 9 million women in the US compared the odds of cesarean sections of uninsured women versus insured women. We found lower odds (0.7) of cesarean sections among uninsured women compared to women with private insurance coverage (Hoxha et al., 2019).

A similar study found that cesarean sections were 1.13 higher among women with private health insurance coverage than women with public insurance coverage, an indication that financial incentives associated with private insurance encourage providers to perform more cesarean deliveries (Hoxha, Syrogiannouli, Braha, et al., 2017).

Regardless of risk factors, the odds of cesarean deliveries are 1.41 times higher in for-profit hospitals than in non-profit hospitals (Hoxha, Syrogiannouli, Luta, et al., 2017).

2.8.3 Race/Ethnicity

The race/ethnicity is also associated with IOL, with 61.1% of non-Hispanic white women more likely to have elective induction than Hispanic women (15.3%) and black women (8.7%) and indicating of the influence of non-patient factors (Hoxha et al., 2019).

3 CHAPTER III METHODOLOGY

3.1 Research Design

A retrospective analysis of hospitalization archival data from the Nationwide Inpatient Sample (NIS) database of the Healthcare Cost and Utilization Project (HCUP) on women aged 20-35 years old in 2001 and 2016 was conducted.

The primary objective of the study was to explore differences in the presence of maternal risk factors, uses of cesarean sections and induction of labor, adverse maternal outcomes (defined by CDC indicators), length of hospital stay, cost of admission (adjusted for inflation), and discharge destination between Millennial and Generation X women in the same age span (20-35).

3.2 Study Population

The population studied included all women aged 20-35 who had child delivery hospitalizations in 2001 and 2016, regardless of the pregnancy outcome. Deliveries for women under 20 years old and over 35 years old will be excluded because they are independent risk factors for adverse maternal outcomes (Walker et al., 2020).

3.3 Data Source

The population-based data for analysis were obtained from the Nationwide Inpatient Sample (NIS) database of the Healthcare Cost and Utilization Project (HCUP) outsourced from the Medical University of South Carolina Research Center.

The NIS database is an all-payer national hospital database sponsored by the Agency for Healthcare Research and Quality (AHRQ). It contains a 20% stratified sample of all US hospital discharges (Nationwide Inpatient Sample, December 2019). The NIS is the only national database with discharge records for all patients, regardless of the payer type (Kozhimannil et al., 2013).

3.4 Data Set Description

The study used the 2001 and 2016 population-based data from the National Inpatient Sample (NIS) database of the Healthcare Cost and Utilization Project (HCUP). The NIS data is de-identified and comprises information related to the population demographics, diagnoses, procedures, and hospital characteristics (Nationwide Inpatient Sample, December 2019).

The database is the only nationally available database in the US that includes all discharges, regardless of the payer. It is audited annually before release to ensure high quality and validity (Metcalfe et al., 2018). The NIS data is de-identified, with each record containing various information, including patient demographics, diagnoses, and hospital characteristics (Nationwide Inpatient Sample, December 2019).

The data set is widely used in health services research, including in maternal health research, to explore national trends in healthcare utilization, quality, and outcome (Kozhimannil et al., 2019; Kozhimannil et al., 2013).

3.5 Independent and Dependent Variables

The operational definition of variables was based on the descriptions by the National Inpatient Sample (NIS) data in HCUP (Nationwide Inpatient Sample, December 2019).

The description of variables (covariates) was based on the HCUP descriptions available on the HCUP website, https://www.hcup-us.ahrq.gov/db/nation/nis/nisdde.jsp.

3.6 Covariates

The covariates (independent variables) used to compare outcomes included age, race/ethnicity, Charlson Comorbidity Index, primary payor type, length of stay, the total cost in dollars.

a. Age: Age in years (AGE) is calculated from the birth date (DOB or reported age at admission and is described as follows in HCUP data

b. *Race/ethnicity*: The race of the patient is coded based on information provided by the source. For our study, the race categories were limited to for types: White, Black, Hispanic, and Other. The "other group" encompassed all races (values 4-B) that were not White, Black, or Hispanic.

Variable	Description	Value	Value Description
RACE	Race	1	White
		2	Black
		3	Hispanic
		4	Asian or Pacific Islander
		5	Native American
		6	Other
		.	Missing
		. A	Invalid
		. B	Unavailable from source (coded in 1988-1997 data only)

Source: www.hcup-us.ahrq.gov

c. *Payor type*: Payor indicates the expected primary payor (Medicare, Medicaid, private insurance, etc.) as provided by the source. For our study, payor was limited to Medicare, Medicaid, Private insurance, and Self-pay. We did not account for the uninsured.

Variable	Description	Value	Value Description
PAY1	Expected primary payer, uniform	1	Medicare
		2	Medicaid
		3	Private insurance
		4	Self-pay
		5	No charge
		6	Other
		.	Missing
		. A	Invalid
		. B	Unavailable from source (coded in 1988-1997 data only)

Source: www.hcup-us.ahrq.gov

d. Length of stay is the difference between the discharge date and the admission date

Variable	Description	Value	Value Description
LOS	Length of stay, cleaned	0 - 365 (for HCUP inpatient data), 0-30 (for HCUP outpatient data)	Days (Prior to the data year 2017, LOS was limited to 0-3 days for outpatient data. In the 1988-1997 inpatient data, LOS can be greater than 365 days)
		.	Missing
		. A	Invalid
		. B	Unavailable from source (coded in 1988-1997 data only)
		.C	Inconsistent: beginning with 1998 data, ELOS03, ELOS04; in 1988-1997 data, ED011, ED601, ED911n, ED921

Source: HCUP

e. The total cost of hospitalization- Costs was weighted for Generation X patients by multiplying total costs by a factor of 1.7

f. Charlson Comorbidity Index score- was based on the coding of the presence or absence of eligible conditions.

3.7 Outcomes Variable

The outcomes of interest include differences in maternal risk factors, use of cesarean sections and induction of labor delivery methods, adverse obstetrical outcomes defined by CDC indicators, length of stay (LOS), cost of admission (adjusted for inflation), and discharge destination.

Adverse maternal outcomes were based on the presence of ICD codes for conditions defined by the CDC using the 21 CDC indicators, including hemorrhage with blood transfusion, infection, eclampsia/preeclampsia, acute renal failure, ventilation, uterine rupture, placenta previa, unplanned hysterectomy (Kuriya et al., 2016; CDC, 2020).

The Code for the CDC events was as follows:

- Code for the CDC events
  - if AcuteMI=1 then CDCEvent=1;
  - if Aneurysm=1 then CDCEvent=1;
  - if AcuteRF=1 then CDCEvent=1;
  - if AdultRespiratoryDS=1 then CDCEvent=1;
  - if AmnioticFE=1 then CDCEvent=1;
  - if CardiacArrest=1 then CDCEvent=1;
  - if ConversionCR=1 then CDCEvent=1;
  - if DisseminatedIC=1 then CDCEvent=1;
  - if Eclampsia=1 then CDCEvent=1;
  - if HeartFailure=1 then CDCEvent=1;
  - if PuerperalCD=1 then CDCEvent=1;
  - if PulmonaryEdema=1 then CDCEvent=1;
  - if AnesthesiaComplication=1 then CDCEvent=1;
  - if Sepsis=1 then CDCEvent=1;
  - if Shock=1 then CDCEvent=1;
  - if SickleCell=1 then CDCEvent=1;
  - if Embolism=1 then CDCEvent=1;
  - if Transfusion=1 then CDCEvent=1;
  - if Hysterectomy=1 then CDCEvent=1;
  - if tracheostomy=1 then CDCEvent=1;
  - if Ventilation=1 then CDCEvent=1;

The table of International Classification of Diseases (ICD) diagnosis and procedure codes used by the CDC identify delivery hospitalizations with SMM is available on the CDC website, https://www.cdc.gov/reproductivehealth/maternalinfanthealth/smm/severe-morbidity-ICD.htm.

3.8 Data Analysis

SAS version 9.4 was used to analyze the data. Descriptive statistics tools were used to summarize the data, including frequency, percentage, mean, standard deviation, cross-tabulations to examine differences between groups, and chi-square and Wilcoxon-Mann-U test to explore the significance of differences in results. Logistic regression was used to describe data and to explain the relationship between independent variables and dependent variables.

We used The SURVEYFREQ Procedure to analyze deliveries by generation, controlling for various variables, age, race, and comorbidity. The Charlson Comorbidity Index was used to categorize and compare patients' comorbidities based on the pre-existing abstracted conditions ICD codes.

3.9 Protection of Human Subjects/Ethical approval

The NIS data from the HCUP is de-identified and meets the criteria for non-human research.

4 CHAPTER IV: RESULTS

The study was a retrospective cohort study using the 2001 and 2016 data from the Nationwide Inpatient Sample (NIS) from the Healthcare Cost and Utilization Project (HCUP) outsourced from the Medical University of South Carolina. Due to the large dataset, practical analysis of the data required the use of the large Comparative Effectiveness Data Analytics Resources (CEDAR) workstations housed at the Medical University of South Carolina. The study population included all women aged 20-35 years in 2001 (Generation X) and women at the same age in 2016 (Millennials) who had childbirth (delivery) hospitalization regardless of the outcome.

The outcomes of interest were as follows:

- Differences in maternal risk factors (comorbidities)
- Use of cesarean sections and induction of labor delivery methods
- Adverse obstetrical outcomes (SMM indicators) as defined by the CDC
- Length of stay (LOS), cost of admission (adjusted for inflation), and discharge

Overall, the analysis included 3,055,937 n(weighted) Millennial women (born 1981-1996) between 20 and 35 years-old in 2016 and 3,005,937 n(weighted) Generation X women (born between 1965-1980) at the same age in 2001 who had delivery hospitalizations. 948,094 (31%) Millennial women were between 20-26 years old compared to 1,135,281 (37.8%) Generation X women. Age group 26-30 comprised 1,125,259 (36.8%) Millennial women compared to 1,033,045 (34.4%) Generation X. The final group, 31-35 years old had 983,584 (32.2%) Millennial women compared to 837,610 (27.9%) Generation X women.

A substantial proportion of older women characterized millennial women, mean age 27.9 versus 27.2 for Generation X, increased length of hospital stay in days (2.6 versus 2.5), and a significant proportion of women on Medicaid (43.2% versus 35.0%). The results also indicate Millennial women were less likely to have private insurance, 50.6% versus 58.7%, and the same was true for self-pay, 2.4% versus 3.2%.

The prevalence of cesarean delivery was higher among Millennial women 961,534 (31.5%) than Generation X women 740,453 (24.6). Millennials also had a higher comorbidity score (0.07 versus 0.02). The results for induced labor indicated a higher rate for Millennial women 1,128,759 (36.9%) than Generation X women 955,342 (31.8%).

Regarding severe maternal morbidity outcomes, findings revealed a higher proportion of blood product transfusion, hysterectomy, infections, eclampsia, and acute renal failure for Millennials versus Generation X.

Summary of results

- Overall, the **analysis** included:
  - 3,055,937 Millennial women
  - 3,005,937 Gen-X women
- Millennial women were characterized by:
  - **Older women**, mean age 27.9 vs. 27.2
  - **Less likely** to have **private insurance**, 50.6% vs.58.7
  - **More likely** to have **Medicaid coverage**, 43.2% vs. 35.0%
  - Higher **comorbidity score** , 0.07 versus 0.02
  - Longer **LOS**
  - Lower **total cost**
- Higher **SMM events**, including blood product transfusion, hysterectomy, infections, eclampsia, and acute renal failure
- 1.32 (95% CI, 1.31 – 1.33) higher odds of **cesarean delivery**
  - Black women were 25% more likely to have cesarean section than white women; Hispanic 9%
- 1.28 (95%CI 1.27-1.29) higher odds of **induced labor**
  - Black women had a 23% reduced chance of being induced than White women, Hispanic women 33%

Additional descriptive statistics on the differences in maternal characteristics between Millennial and Generation X women at the same age, 20-35, are included in Table 6.

Table 6. Demographics and study variables (weighted) stratified by birth generation.

Characteristics	Gen-X n=624,472 n(weighted)=3,005,937	Millennial n=611,188 n(weighted)=3,055,937
Demographic Variables		
Continuous Variables	**Mean (weighted) [95% CI]**	
Age in years	27.2 [27.2-27.2]	27.9 [27.9-27.9]
Length of Stay in days	2.5 [2.5-2.5]	2.6 [2.6-2.6]
Total Cost in dollars*	4,999 [4,989-5,008]	4,868 [4,858-4,878]
Charlson Score	0.02 [0.02-0.02]	0.07 [0.07-0.07]
Categorical Variables	**N (weighted) (%)**	
Race		
Black	261,930 (8.7)	427,765 (14.0)
Hispanic	510,779 (17.0)	574,484 (18.8)
Other	1,052,465 (35.0)	500,650 (16.4)
White	1,180,763 (39.3)	1,553,038 (50.8)
Age Group		
20-25 years old	1,135,281 (37.8)	948,094 (31.0)
26-30 years old	1,033,045 (34.4)	1,124,259 (36.8)
31-35 years old	837,610 (27.9)	983,584 (32.2)
Died	131 (0.0)	145 (0.0)
Indication of Payor		
Medicare	10,849 (0.4)	23,220 (0.8)
Medicaid	1,050,159 (35.0)	1,317,934 (43.2)
Private Insurance	1,760,127 (58.7)	1,544,593 (50.6)
Self-pay	95,815 (3.2)	72,590 (2.4)
Study Variables		
Categorical Variables	**N (weighted) (%)**	
Caesarian	740,453 (24.6)	961,534 (31.5)
Induction	955,342 (31.8)	1,128,759 (36.9)
Cardiovascular Disease/Disorder	1,257 (0.0)	630 (0.0)
Acute Renal Failure	668 (0.0)	3,080 (0.1)
Acute Respiratory Disorders	1,018 (0.0)	2,920 (0.1)
Embolism	454 (0.0)	1,190 (0.0)
Disseminated Intravascular Coagulation	4,162 (0.1)	5,075 (0.2)
Eclampsia	2,325 (0.1)	3,070 (0.1)
Pulmonary Edema	1,213 (0.0)	1,660 (0.1)
Severe Anesthesia Complications	666 (0.0)	200 (0.0)
Infectious Disease/Disorder	1,128 (0.0)	5,230 (0.2)
Sickle Cell Disease with Crisis	304 (0.0)	420 (0.0)
Blood Products Transfusion	12,357 (0.4)	31,630 (1.0)
Hysterectomy	1,820 (0.1)	3,125 (0.1)
*Costs were weighted for Generation-X patients by multiplying total costs by factor of 1.7		

4.1 Differences by Cesarean Delivery

Table 7 uses an unweighted statistic to identify differences by cesarean delivery. A total of 154,672 millennial women between the age of 20 and 35 in 2016 had cesarean delivery compared to 128,792 Generation X women in the same age span in 2001. Millennial women were more likely to be older, mean age 28.5 than Generation X women, mean age 27.9. The length of stay for Millennials was lower than that of Generation X women.

Millennial women compared to Generation X women were more likely to have Medicaid (44.2% versus 35.5%), and less likely to have private insurance (49.7% versus 58.4%). All results were statistically significant, $p<0.0001$. The overall total cost for Millennials who underwent cesarean delivery was lower than that of Generation X women, \$6,528 ± 5,142 versus 7,440 ± 5,423, $P<0.0001$.

The rate of delivery hospitalization with one or more severe maternal morbidity as based on CDC indicators was higher for Millennial women 2.7 n(unweighted=4,250) than Generation X women 1.8 n(unweighted=2,283), p=<0.0001. The rest of the characteristics are as shown in Table 2A.

Our logistic model (The SURVEYLOGISTIC Procedure) adjusted for age and race showed Millennial women had 1.32 (95% CI, 1.31 – 1.33) higher odds of cesarean delivery at the age of 20-35 years than Generation X women at the same age as shown in Table 2AA.

Table 7. **Sub-group analysis of generational demographic differences by Cesarean delivery**

Characteristics	Gen-X n=128,792	Millennial n=154,672	p-value[1]
Demographic Variables			
Continuous Variables	**Mean ± (SD)**		
Age in years	27.9 ± 4.3	28.5 ± 4.1	<0.0001
Length of Stay in days	3.6 ± 3.0	3.3 ± 3.1	<0.0001
Total Cost in dollars*	7,440 ± 5,423	6,528 ± 5,142	<0.0001
Charlson Score	0.0 ± 0.2	0.1 ± 0.3	<0.0001
Categorical Variables	**N (%)**		
Race			<0.0001
Black	12,398 (9.6)	24,087 (15.6)	
Hispanic	24,657 (19.1)	30,164 (19.5)	
Other	41,533 (32.2)	23,684 (15.3)	
White	50,204 (39.0)	76,737 (49.6)	
Age Group			<0.0001
20-25 years old	39,995 (31.1)	39,149 (25.3)	
26-30 years old	44,926 (34.9)	56,768 (36.7)	
31-35 years old	43,871 (34.1)	58,755 (38.0)	
Died	18 (0.0)	19 (0.0)	0.6954
Indication of Payor			<0.0001
Medicare	530 (0.4)	1,441 (0.9)	
Medicaid	45,699 (35.5)	68,334 (44.2)	
Private Insurance	75,186 (58.4)	76,860 (49.7)	
Self-pay	3,557 (2.8)	3,463 (2.2)	
Study Variables			
Categorical Variables	**N (%)**		
*CDC SMM Indicator(s)	2,283 (1.8)	4,250 (2.7)	<0.0001

[1]Statistical Testing: All continuous variables were tested by the Wilcoxon-Mann-U test. Categorical variables were tested by the Chi-Square test.
*Presence of one or more severe maternal morbidity (SMM) indicators as defined by CDC

The odds for cesarean section for Black women were 25% higher than for white women, while that of Hispanic women was 9% higher than for white women, as shown in Table 8. Furthermore, Millennial women had 41% higher odds of comorbidities than Generation X women.

Table 8. Cesarean deliveries for Millennials vs. Gen-X controlling for age and race analysis of maximum likelihood estimates and odds ratio estimates – The SURVEYLOGISTIC procedure

Analysis of Maximum Likelihood Estimates					
Parameter		**Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept		-0.9235	0.00231	-400.38	<.0001
Generat	**Mille**	0.1381	0.00209	66.11	<.0001
Race2	**Black**	0.1670	0.00471	35.47	<.0001
Race2	**Hispa**	0.0232	0.00404	5.76	<.0001
Race2	**Other**	-0.1200	0.00377	-31.82	<.0001
AgeG	**0**	-0.2430	0.00296	-82.23	<.0001
AgeG	**1**	0.0106	0.00281	3.78	0.0002
CharlsScore		0.3431	0.00870	39.43	<.0001

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Confidence Limits**	
Generat Mille vs Gen-X	1.318	1.307	1.329
Race2 Black vs. White	1.268	1.251	1.284
Race2 Hispa vs. White	1.098	1.086	1.110
Race2 Other vs. White	0.951	0.942	0.961
AgeG 0 vs 2	0.622	0.615	0.628
AgeG 1 vs. 2	0.801	0.794	0.809
CharlsScore	1.409	1.385	1.434
NOTE: The degrees of freedom in computing the confidence limits is 1235659.			

4.2 Differences by Induction of Labor

Table 2B shows our sub-group analysis of generational demographic differences by Induction delivery. More Millennials than Generation X women had used induction of labor, n=188,117 versus n=172,166. The mean age for Millennial women was higher than Generation X women 27.6 ± 4.2 versus 27.1 ± 4.4 p <0.0001. Millennial women had the highest (37%) proportion of induction among the 26-30-year-old group and the lowest (29.7%) among the 31-35-year-old group.

In contrast, Generation X women rate of induced labor declined with increased age group (20-25 =39%, 26-30=34%, and 31-35 = 26.6%). The total cost of induction of labor hospitalization was lower for Millennials $4,125 ± 2,727 versus 4,239 ± 2,686 for Generation X, despite Millennials having a longer length of stay (days) and higher comorbidity score, 2.3 ± 1.4 versus 2.1 ± 1.4, and 0.1 ± 0.3 versus 0.0 ± 0.2, respectively. Millennials who had induction of labor were more likely to have SMM events than Generation X women, 1,721 (0.9) versus 820 (0.5), p<0.0001.

Women with private insurance were more likely to be induced, 51.9% for Millennials versus 62.1% for Generation X women (p<0.0001). At the same time, those with Medicaid ranked second in induced labor, 41.8% for Millennials versus 31.9% Generation X women, as shown in Table 9.

The rest of the statistical analysis is, as shown in Table 9.

Table 9. **Generational Demographic Differences by Induction Delivery**

Characteristics	Gen-X n=172,166	Millennial n=188,117	p-value[1]
Demographic Variables			
Continuous Variables	**Mean ± (SD)**		
Age in years	27.1 ± 4.4	27.6 ± 4.2	<0.0001
Length of Stay in days	2.1 ± 1.4	2.3 ± 1.4	<0.0001
Total Cost in dollars*	4,239 ± 2,686	4,125 ± 2,727	<0.0001
Charlson Score	0.0 ± 0.2	0.1 ± 0.3	<0.0001
Categorical Variables	**N (%)**		
Race			<0.0001
Black	12,746 (7.4)	23,311 (12.4)	
Hispanic	22,994 (13.4)	31,282 (16.6)	
Other	62,883 (36.5)	30,207 (16.1)	
White	73,543 (42.7)	103,317 (54.9)	
Age Group			<0.0001
20-25 years old	67,192 (39.0)	62,480 (33.2)	
26-30 years old	59,260 (34.4)	69,688 (37.0)	
31-35 years old	45,714 (26.6)	55,949 (29.7)	
Indication of Payor			<0.0001
Medicare	534 (0.3)	1,371 (0.7)	
Medicaid	54,837 (31.9)	78,607 (41.8)	
Private Insurance	106,911 (62.1)	97,711 (51.9)	
Self-pay	4,542 (2.6)	4,045 (2.2)	
Study Variables			
Categorical Variables	**N (%)**		
*CDC Event	820 (0.5)	1,721 (0.9)	<0.0001

1Statistical Testing: All continuous variables were tested by the Wilcoxon-Mann-U test. Categorical variables were tested by the Chi-Square test.

*Presence of one or more severe maternal morbidity (SMM) indicators as defined by CDC

Table 10 shows our logistic model analysis of induction of labor for Millennial women versus Generation X women, controlling for Age, Race, Comorbidity. Millennial women had 1.28 (95%CI 1.27-1.29) higher odds of being induced than Generation X women. Black women had a 23% reduced chance of being induced than White women and Hispanic women 33% reduced chances of being induced than White women. The odds of comorbidity for Millennials was 5% higher than that of Millennials.

Table 10. Induction Deliveries for Millennials vs. Gen-X controlling for age and race analysis of maximum likelihood estimates and odds ratio estimates – The SURVEYLOGISTIC procedure

Analysis of Maximum Likelihood Estimates					
Parameter		**Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept		-0.7242	0.00225	-322.20	<.0001
Generat	**Mille**	0.1227	0.00197	62.22	<.0001
Race2	**Black**	-0.0796	0.00466	-17.07	<.0001
Race2	**Hispa**	-0.2193	0.00399	-55.00	<.0001
Race2	**Other**	0.1151	0.00353	32.56	<.0001
AgeG	**0**	0.0861	0.00270	31.83	<.0001
AgeG	**1**	0.00843	0.00266	3.16	0.0016
CharlsScore		0.0512	0.00806	6.36	<.0001
NOTE: The degrees of freedom for the t-tests is 1235659.					

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Confidence Limits**	
Generat Mille vs. Gen-X	1.278	1.268	1.288
Race2 Black vs. White	0.768	0.759	0.778
Race2 Hispa vs. White	0.668	0.661	0.675
Race2 Other vs. White	0.934	0.925	0.942
AgeG 0 vs 2	1.198	1.187	1.209
AgeG 1 .vs 2	1.108	1.098	1.119
CharlsScore	1.053	1.036	1.069
NOTE: The degrees of freedom in computing the confidence limits is 1235659.			

4.3 Differences by Induction and Cesarean Delivery

Table C shows the analysis of the differences by induction and cesarean delivery based on unweighted data. A total of 37,635 Millennial women had an induction with cesarean delivery compared to 25,269 Generation X women at the same age, 20-35. Millennial women compared to Generation X were older women (mean age 27.8 versus 27.5, $p<0.0001$) with a higher comorbidity score, 0.1 ± 0.3 versus 0.0 ± 0.2, $p<0.0001$.

While the average length of stay in days was comparable, 3.9 days, Millennials had a higher proportion of SMM events, 3.2 (1,211) compared to 1.6 (394). However, the total cost of hospitalization for Millennial women was lower \$7,701 ± 4,770 versus \$8,451 ± 4,540.

The age group 26-30 had the highest proportion of induction and cesarean, 13,772 (36.6) for Millennials versus 8,996 (35.6), $p<0.0001$ for Generation X women, as indicated in Table 11.

Table 11. Analysis of demographic differences by Induction with Cesarean - delivery

Characteristics	Gen-X n=25,269	Millennial n=37,635	p-value[1]
Demographic Variables			
Continuous Variables	**Mean ± (SD)**		
Age in years	27.5 ± 4.4	27.8 ± 4.3	<0.0001
Length of Stay in days	3.9 ± 2.4	3.9 ± 2.2	<0.0001
Total Cost in dollars*	8,451 ± 4,540	7,701 ± 4,770	<0.0001
Charlson Score	0.0 ± 0.2	0.1 ± 0.3	<0.0001
Categorical Variables	**N (%)**		
Race			<0.0001
Black	2,309 (9.1)	6,286 (16.7)	
Hispanic	3,287 (13.0)	6,266 (16.6)	
Other	9,382 (37.1)	6,151 (16.3)	
White	10,291 (40.7)	18,932 (50.3)	
Age Group			<0.0001
20-25 years old	8,628 (34.1)	12,018 (31.9)	
26-30 years old	8,996 (35.6)	13,772 (36.6)	
31-35 years old	7,645 (30.3)	11,845 (31.5)	
Indication of Payor			<0.0001
Medicare	98 (0.4)	301 (0.8)	
Medicaid	6,960 (27.5)	14,810 (39.4)	
Private Insurance	16,991 (67.2)	20,727 (55.1)	
Self-pay	511 (2.0)	757 (2.0)	
Study Variables			
Categorical Variables	**N (%)**		
*CDC Event	394 (1.6)	1,211 (3.2)	<0.0001

1Statistical Testing: All continuous variables were tested by the Wilcoxon-Mann-U test. Categorical variables were tested by the Chi-Square test.

*Presence of one or more severe maternal morbidity (SMM) indicators as defined by CDC

5 CHAPTER V: DISCUSSION

5.1 Discussion of Results

The analysis used data from the National Inpatient Sample (NIS) from the Healthcare Cost and Utilization Project for the years 2001 and 2016 to explore differences in induction of labor and cesarean delivery for Generation X (born between 1965 and 1980) and Millennial (born between 1981-1996) women aged 20-35 years in each year respectively.

We compared characteristics of women aged group 20-35 -years-old to minimize the effect of the independent risk factor of age. Evidence shows ages under 20- years old and over 35-years-old are independent risk factors for adverse maternal outcomes (Walker et al., 2020).

Overall, our data demonstrated that Millennial women were more likely to be older, have higher comorbidities, higher prevalence of severe maternal morbidity (SMM), and longer length of stay. Furthermore, Millennial women compared to Generation X women were more likely to have Medicaid as their primary payor, less likely to have private insurance, and more likely to have lower overall hospital costs. Further discussion related to outcomes of interest follows below:

5.1.1 Differences in the presence of maternal risk factors

Age, race/ethnicity, insurance, and pre-existing conditions are common maternal risk factors for adverse outcomes. To improve outcomes, deliberate efforts to mitigate these factors are needed. The finding of Millennial women being older than Generation X women was expected and is consistent with evidence from other studies and the data from the National Vital Statistics System, which shows a rise in the mean age of mothers at first birth from 24.9 years in 2000 to 26.3 years in 2014 (Mathews & Hamilton, 2016).

Increased maternal age is consistently linked to increases in pre-pregnancy risk factors that may impact pregnancy outcomes (Burgess et al., 2020; Luke et al., 2019; Mogos et al., 2020; Rydahl et al., 2019). Furthermore, literature examining the impact of advanced maternal age on outcomes has consistently found it to be an independent risk factor for gestational diabetes, preeclampsia, placenta previa, low birth weight (less than 2500 g), and preterm births (Marozio et al., 2019).

Millennials at the same age as Generation X may require a more focused care approach to prevent adverse outcomes. Understanding generation-specific factors that influence delayed motherhood may also be necessary to minimize adverse maternal outcomes associated with age.

Overall, our data revealed a lower proportion of Millennial women compared to Generation X women with private insurance, 50.6% versus 58.7%. This finding was unexpected because we expected the expanded health insurance coverage under the Affordable Care Act (ACA), which allows children under 26 to remain on their parents' insurance policy (French et al., 2016), to work in favor of Millennials. One characteristic that makes Millennials different from other generations is that they grew up in a different health policy environment influenced mainly by the ACA (DePew, 2019).

The plausible explanation for the lower rate of Millennials with private insurance despite expanded coverage provided by the ACA may be explained by the fact that Millennials are delaying motherhood. Most Millennials are becoming mothers for the first time at a mean age of 26.3 years (Mathews & Hamilton, 2016), which is past the age they can remain on their parents' insurance policies. Our data shows a higher mean age for Millennials, 27.9% compared to Generation X 27.2%. It may be helpful for future studies to compare induced labor and cesarean delivery by Millennials aged less than 26-years old and those over 26 years old. The other plausible explanation may be that more Millennials are shunning private insurance because of higher insurance deductibles.

However, our analysis revealed a higher proportion of Millennials on Medicaid 43.2% versus Generation X women 35.0%, which may indicate that more Millennials benefit from the ACA's Medicaid expansion. Our subgroup analysis by procedure type, cesarean delivery, and labor induction revealed a similar pattern in insurance coverage. 49.7% of Millennial women with private insurance had cesarean delivery compared to 58.4% Generation X women.

Overall, our data showed that having private insurance was associated with cesarean delivery and induction of labor across generations. The financial incentives private insurance offers providers may influence this trend. An effective review of the necessity for procedures may reduce severe maternal morbidity or complications associated with cesarean delivery.

5.1.2 Differences in the use of cesarean delivery and induction of labor

The analysis found the prevalence of cesarean delivery was higher among Millennial women than Generation X women. Women in the age group 31-35 years old were 38% more likely to have a cesarean section than women in the age group 20-25 and 20% more likely than women in the 26-30 age group. Black women were 27% more likely to have a cesarean delivery than white women, Hispanic women 9% more likely than white women, and other races 5% less likely than white women.

The results on induction of labor indicated a higher rate for Millennial women (36.9%) than Generation X women (31.8%). Black women across generations were 23% less likely to be induced than white women, Hispanic 33% less likely, and other race 7 % less likely. Our sub-group analysis of generational demographic differences by induction of labor and race shows k Millennial black women had a 5 percent increase in the rate of induction over Generation X women. In contrast, Millennial white women had a 12 percent increase over Generation X white women.

The racial and ethnic disparities in the induction of labor are particularly concerning because growing evidence now links induction of labor in low-risk singleton pregnancies at term and beyond with decreased risks of cesarean delivery or perinatal adverse events, and reduced risk of gestational hypertensive diseases (Caughey et al., 2009; Saccone et al., 2019; Sotiriadis et al., 2019).

Since evidence suggests black women are at a higher risk for adverse maternal outcomes than other races (Burgess et al., 2020; Howell et al., 2020) (Aziz et al., 2019), more needs to be done to ensure lifesaving obstetric interventions reach the target population.

Our data also found that Millennial women had the highest (37%) rate of induction among the 26-30-year-old group and the lowest (29.7%) among the 31-35-year-old group. This finding may confirm that most inductions by Millennial women are elective because evidence shows that most pregnancy complications are associated with advanced maternal age.

The rate of induction of labor among Generation X women declined with increased age group (20-25 =39%, 26-30=34%, and 31-35 = 26.6%). The reason for this pattern is not clear.

5.1.3 Differences in adverse obstetrical outcomes defined by CDC indicators

Our data revealed that Millennial women compared to Generation X women had a higher prevalence of severe maternal morbidity (SMM), 0.9 versus 0.5, p<0.01, including blood product transfusion, hysterectomy, infections, eclampsia, and acute renal failure.

The prevalence of one or more SMM (CDC events) was more significant in women with cesarean delivery, 3.2% for Millennial women versus1.6% for Generation X women. The findings support evidence from our literature review, which indicates that cesarean delivery in low-risk pregnancies is a risk factor for severe maternal morbidly (Clark et al., 2008; Leonard, Main, & Carmichael, 2019). Providers may do well to reduce the number of elective cesarean deliveries to minimize the risk of adverse maternal outcomes.

Several factors may be responsible for the increase in SMM among Millennial women, including increased pre-existing comorbidities, 0.07 versus 0.02, as measured by the Charlson Comorbidity score. The Charlson Comorbidity Index scale is a weighted index scale that accounts for the presence and seriousness of health conditions, including myocardial infarction, diabetes mellitus, congestive heart failure, cerebrovascular disease, and chronic pulmonary disease to predict the one-year mortality rate of a patient (Charlson et al., 1987).

The fact that Millennial women are older, and most of them have Medicaid insurance may be a contributing factor to an increase in SMM. Evidence associates advanced age, Medicaid, or no insurance coverage is associated with a higher risk for adverse maternal outcomes, including deaths from cardiovascular, respiratory, and sepsis-related conditions (Wang et al., 2020).

5.1.4 Differences in length of stay (LOS), cost of admission (adjusted for inflation), and discharge destination.

Although Millennial women had higher comorbidity factors, higher prevalence of SMM, and longer length of stay than Generation X women, their total cost was surprisingly lower than of Generation X women. We found the overall total cost for Millennials who underwent cesarean delivery was lower than that of Generation X women, $6,528 ± 5,142 versus 7,440 ± 5,423, P<0.0001.

We think the fact that Millennial women compared to Generation X women were more likely to have Medicaid (44.2% versus 35.5%), and less likely to have private insurance (49.7% versus 58.4%) may explain the lower total costs. Furthermore, the reduced length of stay for

Millennials 3.3 ± 3.1 versus 3.6 ± 3.0, $p < 0.0001$ for women who had a cesarean delivery, may have contributed to the lower cost.

5.2 Summary

To the best of our knowledge, our study is the first to examine generational-specific differences in induced labor and cesarean delivery between Millennial and Generation X women at precisely the same age using the same variables. Our analysis found evidence of increased rates of cesarean delivery and induced labor even after controlling for age, race, and comorbidity factors among Millennial women. This means obstetric interventions, labor induction, and cesarean delivery may be routinely performed without indications. The findings offer a plausible explanation of why a rapid increase in induced labor and cesarean delivery shows no corresponding evidence of decreasing maternal and neonatal morbidity.

We also found that Millennials are less likely to have private insurance and more likely to have Medicaid coverage than Generation X. The more substantial proportion of Millennials with Medicaid is concerning as several studies have associated public insurance coverage with poor outcomes. An effective quality review process of the care provided to patients with public insurance may mitigate adverse outcomes.

Finally, we established that Millennial women had increased comorbidities, severe maternal morbidity, and increased length of hospital stay than Generation X. To our surprise, these factors did not translate into a higher cost of hospitalization related to lower reimbursement rates by Medicaid.

5.3 Limitations/Future Studies

Our study has several weaknesses and limitations. First, it's crucial to establish that the main focus of our analysis was to determine differences in the demographic and clinical characteristics between Millennial and Generation X women associated with the use of induced labor and cesarean delivery procedure. As a result, we did not primarily focus on determining causation.

Second, our study did not control for individual patient's existing conditions in determining risk factors. Instead, we used the Charlson Comorbidity index scale that includes some of the variables that are not particularly relevant to maternal health. Future studies may wish to explore the impact of individual conditions to identify conditions that may be responsible for higher rates of induction and cesarean procedures among Millennials.

Third, our study used archival data, which limits the kind of analysis that can be done on the available variables or elements. The analysis was limited by the availability and accuracy of the coded variables. For example, we needed to compare outcomes of interest by median income, region, and hospital type, but we could not find data for Generation X women. Also, the archival data used was drawn from two different datasets that were coded differently. The 2001 data was coded using ICD 9, whereas the 2016 dataset was coded using ICD 10.

Fourth, our study did not identify generation-specific behaviors/attitudes that influence treatment preferences. Future studies may wish to explore generational-specific practices that affect choices of individual obstetric interventions.

Finally, the study did not compare indications for induced labor/cesarean delivery based on ACOG recommendation for the two groups, a critical focus for future research to help identify changes in indications associated with various obstetric interventions.

5.4 Conclusion

Despite some limitations, our study reveals the importance of recognizing generational-specific changes in maternal characteristics that may influence access to care, care preferences, and outcomes. As Millennial women now account for the vast majority of all US childbirths, exploring maternal health characteristics specific to Millennials is necessary to recognize potential trends and opportunities for improvement. Taking care of Millennial women and improving their maternal outcomes will require multifaceted approaches, including implementation of policies that reduce barriers to access, promote equity, and preventative care.

6 References

ACOG Committee on Practice Bulletins – Obstetrics. (2009). Practice Bulletin No. 107: Induction of labor. Obstetrics & Gynecology, 114(2 Pt 1), 386-397. https://doi.org/10.1097/AOG.0b013e3181b48ef5

Acosta, C. D., Knight, M., Lee, H. C., Kurinczuk, J. J., Gould, J. B., & Lyndon, A. (2013). The continuum of maternal sepsis severity: Incidence and risk factors in a population-based cohort study. PLoS One, 8(7), Article e67175. https://doi.org/10.1371/journal.pone.0067175

Admon, L. K., Winkelman, T. N. A., Zivin, K., Terplan, M., Mhyre, J. M., & Dalton, V. K. (2018). Racial and ethnic disparities in the incidence of severe maternal morbidity in the United States, 2012-2015. Obstetrics & Gynecology, 132(5), 1158-1166. https://doi.org/10.1097/AOG.0000000000002937

Akinsipe, D. C., Villalobos, L. E., & Ridley, R. T. (2012). A systematic review of implementing an elective labor induction policy. Journal of Obstetric, Gynecologic, & Neonatal Nursing, 41(1), 5-16. https://doi.org/10.1111/j.1552-6909.2011.01320.x

Amerian College of Obstetricians and Gynecologists, & Society for Maternal-Fetal Medicine. (2014). Obstetric care consensus no. 1: Safe prevention of the primary cesarean delivery. Obstetrics & Gynecology, 123(3), 693-711. https://doi.org/10.1097/01.AOG.0000444441.04111.1d

Ananth, C. V., Wilcox, A. J., & Gyamfi-Bannerman, C. (2013). Obstetrical interventions for term first deliveries in the US. Paediatric and Perinatal Epidemiology, 27(5), 442-451. https://doi.org/10.1111/ppe.12068

Aziz, A., Gyamfi-Bannerman, C., Siddiq, Z., Wright, J. D., Goffman, D., Sheen, J. J., D'Alton, M. E., & Friedman, A. M. (2019). Maternal outcomes by race during postpartum readmissions. American Journal of Obstetrics and Gynecology, 220(5), 484.e1-484.e10. https://doi.org/10.1016/j.ajog.2019.02.016

Berg, C. J., Callaghan, W. M., Syverson, C., & Henderson, Z. (2010). Pregnancy-related mortality in the United States, 1998 to 2005. Obstetrics & Gynecology, 116(6). https://doi.org/10.1097/AOG.0b013e3181fdfb11

Bernardes, T. P., Zwertbroek, E. F., Broekhuijsen, K., Koopmans, C., Boers, K., Owens, M., Thornton, J., van Pampus, M. G., Scherjon, S. A., Wallace, K., Langenveld, J., van den Berg, P. P., Franssen, M. T. M., Mol, B. W. J., & Groen, H. (2019). Delivery or expectant management for prevention of adverse maternal and neonatal outcomes in hypertensive disorders of pregnancy: An individual participant data meta-analysis. Ultrasound in Obstetrics & Gynecology, 53(4), 443-453. https://doi.org/10.1002/uog.20224 [doi]

Boyle, A., Reddy, U. M., Landy, H. J., Huang, C. C., Driggers, R. W., & Laughon, S. K. (2013). Primary cesarean delivery in the United States. Obstetrics & Gynecology, 122(1), 33-40. https://doi.org/10.1097/AOG.0b013e3182952242

Burgess, A. P. H., Dongarwar, D., Spigel, Z., Salihu, H. M., Moaddab, A., Clark, S. L., & Fox, K. (2020). Pregnancy-related mortality in the United States, 2003-2016: Age, race, and place of death. American Journal of Obstetrics and Gynecology, 222(5), 489.e1-489.e8. https://doi.org/10.1016/j.ajog.2020.02.020

Callaghan, W. M., Creanga, A. A., & Kuklina, E. V. (2012). Severe maternal morbidity among delivery and postpartum hospitalizations in the United States. Obstetrics and Gynecology, 120(5), 1029-1036. https://doi.org/http://10.1097/AOG.0b013e31826d60c5

Caughey, A. B., Sundaram, V., Kaimal, A. J., Gienger, A., Cheng, Y. W., McDonald, K. M., Shaffer, B. L., Owens, D. K., & Bravata, D. M. (2009). Systematic review: elective induction of labor versus expectant management of pregnancy. Annals of Internal Medicine, 151(4), 252-263, W253-263. https://doi.org/10.7326/0003-4819-151-4-200908180-00007

Cavazos-Rehg, P. A., Krauss, M. J., Spitznagel, E. L., Bommarito, K., Madden, T., Olsen, M. A., Subramaniam, H., Peipert, J. F., & Bierut, L. J. (2015). Maternal age and risk of labor and delivery complications. Maternal and Child Health Journal, 19(6), 1202-1211. https://doi.org/10.1007/s10995-014-1624-7

Centers for disease control and prevention. (2020, January 31). Severe maternal morbidity. Retrieved June 24, 2020, from https://www.cdc.gov/reproductivehealth/maternalinfanthealth/smm/rates-severe-morbidity-indicator.htm

Centers for disease control and prevention. (2020, February 20). Pregnancy mortality surveillance system . Retrieved July 30, 2020, from https://www.cdc.gov/reproductivehealth/maternal-mortality/pregnancy-mortality-surveillance-system.htm

Centers for disease control and prevention. (2020, May). Pregnancy-related deaths. Retrieved July 30, 2020, from https://www.cdc.gov/vitalsigns/maternal-deaths/index.html

Chang, J., Elam-Evans, L. D., Berg, C. J., Herndon, J., Flowers, L., Seed, K. A., & Syverson, C. J. (2003). Pregnancy-related mortality surveillance--United States, 1991--1999. MMWR Surveillance Summary, 52(SS-2), 1-8.

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation.

Journal of Chronic Diseases, 40(5), 373-383. https://doi.org/10.1016/0021-9681(87)90171-8

Cluver, C., Novikova, N., Koopmans, C. M., & West, H. M. (2017). Planned early delivery versus expectant management for hypertensive disorders from 34 weeks gestation to term. Cochrane Database of Systematic Reviews. https://doi.org/10.1002/14651858.CD009273.pub2

Collier, A. Y., & Molina, R. L. (2019). Maternal mortality in the United States: Updates on trends, causes, and solutions. Neoreviews, 20(10), e561-e574. https://doi.org/10.1542/neo.20-10-e561

Creanga, A. A., Berg, C. J., Syverson, C., Seed, K., Bruce, F. C., & Callaghan, W. M. (2015). Pregnancy-related mortality in the United States, 2006-2010. Obstetrics & Gynecology, 125(1), 5-12. https://doi.org/10.1097/AOG.0000000000000564

Creanga, A. A., Syverson, C., Seed, K., & Callaghan, W. M. (2017). Pregnancy-related mortality in the United States, 2011-2013. Obstetrics & Gynecology, 130(2), 366-373. https://doi.org/10.1097/AOG.0000000000002114

Darney, B. G., Snowden, J. M., Cheng, Y. W., Jacob, L., Nicholson, J. M., Kaimal, A., Dublin, S., Getahun, D., & Caughey, A. B. (2013). Elective induction of labor at term compared with expectant management: maternal and neonatal outcomes. Obstetrics & Gynecology, 122(4), 761-769. https://doi.org/10.1097/AOG.0b013e3182a6a4d0

Dekker, G. A. (2014). Management of preeclampsia. Pregnancy Hypertension, 4(3), 246-247. https://doi.org/10.1016/j.preghy.2014.04.021

DePew, R., & Gonzales, G. (2020). Differences in health outcomes between Millennials and Generation X in the USA: Evidence from the National Health Interview Survey.

Population Research and Policy Review, 39, 605-616. https://doi.org/10.1007/s11113-019-09563-w

Dublin, S., Johnson, K. E., Walker, R. L., Avalos, L. A., Andrade, S. E., Beaton, S. J., Davis, R. L., Herrinton, L. J., Pawloski, P. A., Raebel, M. A., Smith, D. H., Toh, S., & Caughey, A. B. (2014). Trends in elective labor induction for six United States health plans, 2001-2007. Journal of Women's Health, 23(11), 904-911. https://doi.org/10.1089/jwh.2014.4779

Fingar, K. R., Hambrick, M. M., Heslin, K. C., & Moore, J. E. (2006). Trends and disparities in delivery hospitalizations involving severe maternal morbidity, 2006-2015: Statistical Brief #243. In the Healthcare Cost and Utilization Project (HCUP) Statistical Briefs (pp. 1-21). Agency of Healthcare Research and Quality. https://www.ncbi.nlm.nih.gov/books/NBK532465/

Firoz, T., Chou, D., von Dadelszen, P., Agrawal, P., Vanderkruik, R., Tunçalp, O., Magee, L. A., van Den Broek, N., Say, L., & Group, M. M. W. (2013). Measuring maternal health: Focus on maternal morbidity. Bulletin of the World Health Organization, 91(10), 794-796. https://doi.org/10.2471/BLT.13.117564

French, M., Homer, J., Gumus, G., & Hickling, L. (2016). Key provisions of the patient protection and Affordable Care Act (ACA): A systematic review and presentation of early research findings. Health Services Research, 51(5), 1735-1771. https://doi.org/10.1111/1475-6773.12511

Fry, R. (2020, April 28). Millennials overtake baby boomers as America's largest generation. Pew research center. https://www.pewresearch.org/fact-tank/2020/04/28/millennials-overtake-baby-boomers-as-americas-largest-generation/

Gao, C., Osmundson, S., Yan, X., Edwards, D. V., Malin, B. A., & Chen, Y. (2019). Learning to identify severe maternal morbidity from electronic health records. Studies in Health Technology and Informatics, 264, 143-147. https://doi.org/10.3233/SHTI190200

Geller, S. E., Rosenberg, D., Cox, S. M., & Kilpatrick, S. (2002). Defining a conceptual framework for near-miss maternal morbidity. Journal of the American Medical Women's Association, 57(3), 135-139.

Gibbs Pickens, C. M., Kramer, M. R., Howards, P. P., Badell, M. L., Caughey, A. B., & Hogue, C. J. (2018). Term elective induction of labor and pregnancy outcomes among obese women and their offspring. Obstetrics & Gynecology, 131(1), 12-22. https://doi.org/10.1097/AOG.0000000000002408

Glance, L. G., Dick, A. W., Glantz, J. C., Wissler, R. N., Qian, F., Marroquin, B. M., Mukamel, D. B., & Kellermann, A. L. (2014). Rates of major obstetrical complications vary almost fivefold among US hospitals. Health Affairs, 33(8), 1330-1336. https://doi.org/10.1377/hlthaff.2013.1359

Goffman, D., Madden, R. C., Harrison, E. A., Merkatz, I. R., & Chazotte, C. (2007). Predictors of maternal mortality and near-miss maternal morbidity. Journal of Perinatology, 27(10), 597-601. https://doi.org/10.1038/sj.jp.7211810

Grobman, W. A., & Caughey, A. B. (2019). Elective induction of labor at 39 weeks compared with expectant management: A meta-analysis of cohort studies. Americal Journal of Obstetrics and Gynecology, 221(4), 304-310. https://doi.org/10.1016/j.ajog.2019.02.046

Grobman, W. A., Rice, M. M., Reddy, U. M., Tita, A. T. N., Silver, R. M., Mallett, G., Hill, K., Thom, E. A., El-Sayed, Y. Y., Perez-Delboy, A., Rouse, D. J., Saade, G. R., Boggess, K. A., Chauhan, S. P., Iams, J. D., Chien, E. K., Casey, B. M., Gibbs, R. S., Srinivas, S. K., Swamy, G. K., Simhan, H. N., Macones, G. A., & Network, E. K. S. N. I. o. C. H. a. H. D. M. F. M. U. (2018). Labor induction versus expectant management in low-risk nulliparous women. New England Journal of Medicine, 379(6), 513-523. https://doi.org/10.1056/NEJMoa1800566

Gunja, M. Z., Tikkanen, R., Seervai, S., & Collins, S. R. (2018). What is the status of women's health and health care in the U.S. compared to ten other countries? Commonwealth Fund. https://doi.org/10.26099/wy8a-7w13

Hamilton, B. E., Hoyert, D. L., Martin, J. A., Strobino, D. M., & Guyer, B. (2013). Annual summary of vital statistics: 2010-2011. Pediatrics, 131(3), 548-558. https://doi.org/10.1542/peds.2012-3769

Haroon, F., Dhrolia, M. F., Qureshi, R., Imtiaz, S., & Ahmed, A. (2019). Frequency of pregnancy-related complications causing acute kidney injury in pregnant patients at a tertiary care hospital. Saudi Journal of Kidney Diseases and Transplantation, 30(1), 194-201. https://doi.org/SaudiJKidneyDisTranspl_2019_30_1_194_252910 [pii]

Heard, A. R., Dekker, G. A., Chan, A., Jacobs, D. J., Vreeburg, S. A., & Priest, K. R. (2004). Hypertension during pregnancy in South Australia, part 1: Pregnancy outcomes. Australian and New Zealand Journal of Obstetrics and Gynaecology, 44(5), 404-409. https://doi.org/10.1111/j.1479-828X.2004.00267.x

Howell, E. A., Brown, H., Brumley, J., Bryant, A. S., Caughey, A. B., Cornell, A. M., Grant, J. H., Gregory, K. D., Gullo, S. M., Kozhimannil, K. B., Mhyre, J. M., Toledo, P., D'Oria, R., Ngoh, M., & Grobman, W. A. (2018). Reduction of peripartum racial and ethnic disparities: A conceptual framework and maternal safety consensus bundle. Journal of

Obstetric, Gynecologic, & Neonatal Nursing, 47(3), 275-289. https://doi.org/10.1016/j.jogn.2018.03.004

Howell, E. A., Egorova, N. N., Janevic, T., Brodman, M., Balbierz, A., Zeitlin, J., & Hebert, P. L. (2020). Race and ethnicity, medical insurance, and within-hospital severe maternal morbidity disparities. Obstetrics & Gynecology, 135(2), 285-293. https://www.doi.org/10.1097/AOG.0000000000003667

Howland, R. E., Angley, M., Won, S. H., Wilcox, W., Searing, H., Liu, S. Y., & Johansson, E. W. (2019). Determinants of severe maternal morbidity and its racial/ethnic disparities in New York City, 2008-2012. Maternal and Child Health Journal, 23(3), 346-355. https://doi.org/10.1007/s10995-018-2682-z

Hoxha, I., Braha, M., Syrogiannouli, L., Goodman, D. C., & Jüni, P. (2019). Cesarean section in uninsured women in the USA: A systematic review and meta-analysis. BMJ Open, 9(3), Article e025356. https://doi.org/10.1136/bmjopen-2018-025356

Hoxha, I., Syrogiannouli, L., Braha, M., Goodman, D. C., da Costa, B. R., & Jüni, P. (2017). Cesarean sections and private insurance: systematic review and meta-analysis. BMJ Open, 7(8), Article e016600. https://doi.org/10.1136/bmjopen-2017-016600

Hoxha, I., Syrogiannouli, L., Luta, X., Tal, K., Goodman, D. C., da Costa, B. R., & Jüni, P. (2017). Cesarean sections and for-profit status of hospitals: systematic review and meta-analysis. BMJ Open, 7(2), Article e013670. https://doi.org/10.1136/bmjopen-2016-013670

Kean, N., Turner, J., Flatley, C., ClinEpi, M., & Kumar, S. (2020). Maternal age potentiates the impact of operative birth on serious neonatal outcomes. The Journal of Maternal-Fetal & Neonatal Medicine, 33(4), 598-605. https://doi.org/10.1080/14767058.2018.1498478

Kortekaas, J. C., Kazemier, B. M., Keulen, J. K. J., Bruinsma, A., Mol, B. W., Vandenbussche, F., Van Dillen, J., & De Miranda, E. (2020). Risk of adverse pregnancy outcomes of late- and post-term pregnancies in advanced maternal age: A national cohort study. Acta Obstetricia et Gynecologica Scandinavica, 99(8), 1022-1030. https://doi.org/10.1111/aogs.13828

Kozhimannil, K. B., Interrante, J. D., Henning-Smith, C., & Admon, L. K. (2019). Rural-urban differences in severe maternal morbidity and mortality in the US, 2007-15. Health Affairs, 38(12), 2077-2085. https://doi.org/10.1377/hlthaff.2019.00805

Kozhimannil, K. B., Shippee, T. P., Adegoke, O., & Vemig, B. A. (2013). Trends in hospital-based childbirth care: The role of health insurance. American Journal of Managed Care, 19(4), e125-132.

Kuriya, A., Piedimonte, S., Spence, A. R., Czuzoj-Shulman, N., Kezouh, A., & Abenhaim, H. A. (2016). Incidence and causes of maternal mortality in the USA. Journal of Obstetrics and Gynaecological Research, 42(6), 661-668. https://doi.org/10.1111/jog.12954

Lee, V. R., Darney, B. G., Snowden, J. M., Main, E. K., Gilbert, W., Chung, J., & Caughey, A. B. (2016). Term elective induction of labor and perinatal outcomes in obese women: Retrospective cohort study. BJOG: An International Journal of Obstetrics & Gynaecology, 123(2), 271-278. https://doi.org/10.1111/1471-0528.13807

Leonard, S. A., Main, E. K., & Carmichael, S. L. (2019). The contribution of maternal characteristics and cesarean delivery to an increasing trend of severe maternal morbidity. BMC Pregnancy and Childbirth, 19(1), Article 16. https://doi.org/10.1186/s12884-018-2169-3

Leonard, S. A., Main, E. K., Scott, K. A., Profit, J., & Carmichael, S. L. (2019). Racial and ethnic disparities in severe maternal morbidity prevalence and trends. Annals of Epidemiology, 33, 30-36. https://doi.org/10.1016/j.annepidem.2019.02.007

Levine, L. D., Downes, K. L., Hamm, R. F., & Srinivas, S. K. (2019). Evaluating the impact of a standardized induction protocol to reduce adverse perinatal outcomes: A prospective cohort study. The Journal of Maternal-Fetal & Neonatal Medicine. Advance online publication. https://doi.org/10.1080/14767058.2019.1680629

Liese, K. L., Mogos, M., Abboud, S., Decocker, K., Koch, A. R., & Geller, S. E. (2019). Racial and ethnic disparities in severe maternal morbidity in the United States. Journal of Racial and Ethnic Health Disparities, 6(4), 790-798. https://doi.org/10.1007/s40615-019-00577-w

Lipkind, H. S., Zuckerwise, L. C., Turner, E. B., Collins, J. J., Campbell, K. H., Reddy, U. M., Illuzi, J. L., & Merriam, A. A. (2019). Severe maternal morbidity during delivery hospitalization in a large international administrative database, 2008-2013: A retrospective cohort. BJOG: An International Journal of Obstetrics & Gynaecology, 126(10), 1223-1230. https://doi.org/10.1111/1471-0528.15818

Lloyd, T., Shaffer, M. L., Christy, S., Widome, M. D., Repke, J., Weitekamp, M. R., Eslinger, P. J., Bargainnier, S. S., & Paul, I. M. (2013). Health knowledge among the millennial generation. Journal of Public Health Research, 2(1), 38-41. https://doi.org/10.4081/jphr.2013.e8

Loktionov, D., McCarthy, C. M., & Skehan, M. C. (2019). Does an elective induction policy negatively impact on vaginal delivery rates? A 30-month review of an elective induction policy. Irish Journal of Medical Science, 188(2), 563-567. https://doi.org/10.1007/s11845-018-1883-1

Luke, B., Brown, M. B., Wantman, E., Baker, V. L., Doody, K. J., Seifer, D. B., & Spector, L. G. (2019). Risk of severe maternal morbidity by maternal fertility status: A US study in 8 states. American Journal of Obstetrics and Gynecology, 220(2), 195.e1-195.e12. https://doi.org/10.1016/j.ajog.2018.10.012

Main, E. K., Chang, S. C., Dhurjati, R., Cape, V., Profit, J., & Gould, J. B. (2020). Reduction in racial disparities in severe maternal morbidity from hemorrhage in a large-scale quality improvement collaborative. American Journal of Obstetrics and Gynecology, 223(1), 123.e1-123.e14. https://doi.org/10.1016/j.ajog.2020.01.026

Marconi, A. M. (2019). Recent advances in the induction of labor. F1000Research, 8, Article 1829. https://doi.org/10.12688/f11000research.17587.12681

Marozio, L., Picardo, E., Filippini, C., Mainolfi, E., Berchialla, P., Cavallo, F., Tancredi, A., & Benedetto, C. (2019). Maternal age over 40 years and pregnancy outcome: A hospital-based survey. The Journal of Maternal-Fetal & Neonatal Medicine, 32(10), 1602-1608. https://doi.org/10.1080/14767058.2017.1410793

Marrs, C., La Rosa, M., Caughey, A., & Saade, G. (2019). Elective induction at 39 weeks of gestation and the implications of a large, multicenter, randomized controlled trial. Obstetrics & Gynecology, 133(3), 445-450. https://doi.org/10.1097/AOG.0000000000003137

Martin, J. A., Hamilton, B. E., & Osterman, M. J. K. (2019). Births in the United States, 2018 (NCHS Data Brief No. 36). National Center for Health Statistics, Centers for Disease Control and Prevention. https://www.cdc.gov/nchs/products/databriefs/db346.htm

Martin, J. A., Hamilton, B. E., Osterman, M. J. K., Driscoll, A. K., & Drake, P. (2018). Births: Final data for 2017. National Vital Statistics Reports, 67(8), 1-50. https://www.cdc.gov/nchs/data/nvsr/nvsr67/nvsr67_08-508.pdf

Mathews, T. J., & Hamilton, B. E. (2016). Mean age of mothers is on the rise: United States, 2000-2014 (NCHS Data Brief No. 232). National Center for Health Statistics, Centers for Disease Control and Prevention. https://www.cdc.gov/nchs/products/databriefs/db232.htm

Metcalfe, A., Wick, J., & Ronksley, P. (2018). Racial disparities in comorbidity and severe maternal morbidity/mortality in the United States: An analysis of temporal trends. Acta Obstetricia et Gynecolgica Scandinavica, 97(1), 89-96. https://doi.org/10.1111/aogs.13245

Middleton, P., Shepherd, E., & Crowther, C. A. (2018). Induction of labor for improving birth outcomes for women at or beyond term. Cochrane Database of Systematic Reviews. https://doi.org/10.1002/14651858.CD004945.pub4

Mogos, M. F., Liese, K. L., Thornton, P. D., Manuck, T. A., O'Brien, W. D., & McFarlin, B. L. (2020). Inpatient maternal mortality in the United States, 2002-2014. Nursing Research, 69(1), 42-50. https://doi.org/10.1097/NNR.0000000000000397

Moore, J., & Low, L. K. (2012). Factors that influence the practice of elective induction of labor: What does the evidence tell us? The Journal of Perinatal & Neonatal Nursing, 26(3), 242-250. https://doi.org/10.1097/JPN.0b013e31826288a9

Petersen, E. E., Davis, N. L., Goodman, D., Cox, S., Mayes, N., Johnston, E., Syverson, C., Seed, K., Shapiro-Mendoza, C. K., Callaghan, W. M., & Barfield, W. (2019). Vital signs: Pregnancy-related deaths, United States, 2011-2015, and strategies for prevention, 13

States, 2013-2017. MMWR, 68(18), 423-429. https://doi.org/10.15585/mmwr.mm6818e1 [doi]

Petersen, E. E., Davis, N. L., Goodman, D., Cox, S., Syverson, C., Seed, K., Shapiro-Mendoza, C., Callaghan, W. M., & Barfield, W. (2019). Racial/ethnic disparities in pregnancy-related deaths - United States, 2007-2016. MMWR, 68(35), 762-765. https://doi.org/10.15585/mmwr.mm6835a3

Rydahl, E., Declercq, E., Juhl, M., & Maimburg, R. D. (2019). Cesarean section on a rise-Does advanced maternal age explain the increase? A population register-based study. PLoS One, 14(1), Article e0210655. https://doi.org/10.1371/journal.pone.0210655

Saccone, G., Della Corte, L., Maruotti, G. M., Quist-Nelson, J., Raffone, A., De Vivo, V., Esposito, G., Zullo, F., & Berghella, V. (2019). Induction of labor at full-term in pregnant women with uncomplicated singleton pregnancy: A systematic review and meta-analysis of randomized trials. Acta Obstetricia et Gynecologica Scandinavica, 98(8), 958-966.

Sgayer, I., & Frank Wolf, M. (2019). Induction of labor at 39 weeks of gestation versus expectant management. Harefuah, 158(12), 802-806.

Sotiriadis, A., Petousis, S., Thilaganathan, B., Figueras, F., Martins, W. P., Odibo, A. O., Dinas, K., & Hyett, J. (2019). Maternal and perinatal outcomes after elective induction of labor at 39 weeks in uncomplicated singleton pregnancy: A meta-analysis. Ultrasound in Obstetrics & Gynecology, 53(1), 26-35. https://doi.org/10.1002/uog.20140

Souter, V., Painter, I., Sitcov, K., & Caughey, A. B. (2019). Maternal and newborn outcomes with elective induction of labor at term. American Journal of Obstetrics and Gynecology, 220(3), 273.e1-273.e11. https://doi.org/10.1016/j.ajog.2019.01.223

Stock, S. J., Ferguson, E., Duffy, A., Ford, I., Chalmers, J., & Norman, J. E. (2012). Outcomes of elective induction of labor compared with expectant management: Population-based study. BMJ, 344, Article e2838. https://doi.org/10.1136/bmj.e2838

Teitler, J. O., Plaza, R., Hegyi, T., Kruse, L., & Reichman, N. E. (2019). Elective deliveries and neonatal outcomes in full-term pregnancies. American Journal of Epidemiology, 188(4), 674-683. https://doi.org/10.1093/aje/kwz014

Tsakiridis, I., Mamopoulos, A., Athanasiadis, A., & Dagklis, T. (2020). Induction of labor: An overview of guidelines. Obstetrical & Gynecological Survey, 75(1), 61-72. https://doi.org/10.1097/OGX.0000000000000752

Walker, A. R., Waites, B. T., & Caughey, A. B. (2020). The impact of extremes of maternal age on maternal and neonatal pregnancy outcomes in women with pregestational diabetes mellitus. The Journal of Maternal-Fetal & Neonatal Medicine, 33(3), 437-441. https://doi.org/10.1080/14767058.2018.1494713

Wang, E., Glazer, K. B., Howell, E. A., & Janevic, T. M. (2020). Social determinants of pregnancy-related mortality and morbidity in the United States: A systematic review. ObObstetrics Gynecology, 135(4), 896-915. https://doi.org/10.1097/AOG.0000000000003762

Wen, T., Wright, J. D., Goffman, D., D'Alton, M. E., Attenello, F. J., Mack, W. J., & Friedman, A. M. (2019). Hypertensive postpartum admissions among women without a history of hypertension or preeclampsia. ObObstetrics Gynecology, 133(4), 712-719. https://doi.org/10.1097/AOG.0000000000003099

White, D., & Wurn. M.A. (2019, September 27). The economic consequences of millennial health. Blue cross blues shield moody's analytics. Retrieved from https://www.bcbs.com/sites/default/files/file-attachments/health-of-america-report/HOA-Moodys-Millennial-10-30.pdf

Wilson, R. E., & Salihu, H. M. (2007). The paradox of obstetric "near misses": converting maternal mortality into morbidity. International Journal of Fertility and Women’s Medicine, 52(2-3), 121-127.