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READMISSION RATES OF MOTHERS EXPERIENCING PREECLAMPSIA OR  
COMPLICATIONS AFTER DELIVERY IN UNDERSERVED POPULATIONS

BY

Sadia M. Robinson

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

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COMPLICATIONS AFTER DELIVERY IN UNDERSERVED POPULATIONS

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Sadia M. Robinson

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Abstract of Doctoral Project Presented to the  
Medical University of South Carolina  
In Partial Fulfillment of the Requirements for the  
Degree of Doctor of Health Administration

READMISSION RATES OF MOTHERS EXPERIENCING PREECLAPSA OR  
COMPLICATIONS AFTER DELIVERY IN UNDERSERVED POPULATIONS

by

Sadia M. Robinson, MPH

Chairperson: [Abby Swanson Kazley, PhD]  
Committee: [Brandi L. Wright, PhD]  
                  [Kit Simpson, PhD]

*Hospital readmissions during pregnancy nationwide impacts maternal health outcomes elevating the risk of maternal deaths after discharge. The accessibility and affordability of necessary prenatal care is integral to the field of health across the lifespan. Socioeconomic barriers within rural locations place expecting mothers at an adverse risk of developing conditions including preeclampsia and other complications that may result in hospital readmission. Economic barriers including hospital closures, shortages of specialty healthcare providers, unstable internet access and, ease of care access on further contribute to this disparity among rural women.*

*A retrospective analysis was conducted using data from Health Care Cost and Utilization Project for the state of Florida in 2019, comparing rural versus non rural zip codes. This analysis was conducted to assess the rate of admission for mothers experiencing preeclampsia and pregnancy related complications that lived in rural settings within the state. As Public Health Maternal and Child Health graduate and former employee of REACHUP, Incorporated, I have observed many barriers and socio-economic factors impacting rural maternal health. The provision of multifaceted support, emphasizing patient advocacy, and monitoring efforts to address medical concerns for women experiencing medical emergencies and additional barriers to care is necessary in addressing this disparity.*

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## CHAPTER I INTRODUCTION

### 1.1 Background and Need

Preeclampsia is a hypertensive medical condition affecting women during pregnancy and post-delivery, causing deleterious implications for both mothers and infants (Cunningham et al., 2018). Conditions of preeclampsia may give rise to increased damage to major organs and pregnancy related death if left undetected or untreated (LaMarca et al., 2016). Preeclampsia along with other pregnancy-related medical conditions can increase the rate of rehospitalization, inciting adverse side effects impacting heart and kidney function, blood pressure, and long-term challenges for both women and unborn fetuses. These pregnancy related illnesses affect between 2-8% of pregnancies worldwide, while disproportionately affecting women living in rural areas (Sharma et al., 2020). Populations of women in less suburban areas experience the maternal burden of a preeclamptic diagnosis at a rate of 13.7-23.7 per 1,000 live births compared to women living in urban settings (10.5-20.0 per 1,000 live births) (Sharma et al., 2020).

Birth-related hypertension is the leading cause of postpartum readmission, placing women diagnosed with preeclampsia at an increased risk of seeking medical attention (CDC, 2022). An analysis of Healthcare Cost and Utilization Project data from 2005-2014, identify women living in poor rural locations have experienced elevated rates of preeclampsia and pregnancy-related complications. This finding highlights elevated rates for women living in rural areas by nearly 20%, from 44.3 to 53.2 per 1,000 deliveries in 2014 (Fingar et al., 2017). Compared to more significant regions with improved access to obstetric care, women in these areas experience readmission at an even higher risk of adverse health outcomes (Clapp et al., 2016).

Barriers including infrastructural limitations of care including quality care access, limited means of transportation, level of insurance, and additional barriers of access to telehealth services (Sharma et al., 2020). Disparities of race and culture along with other SODH factors like education, acquisition of affordable housing, and existence of comorbidities contribute to health-related gaps and access limitations

among this population (Douhit et al., 2015). Preeclampsia and other pregnancy related conditions produce an increased rate of hospital readmission for mothers, highlighting the need for sustainable efforts to quickly diagnose and monitor at risk women and thwart potentially life-threatening adversities (Lee et al., 2015).

Research identifies preeclampsia and hypertension as prominent indications for postpartum readmission among pregnant women (Clapp et al., 2016). Location-based health disparities has become a priority of health-related organizations, highlighting that woman living in more rural locations are at an increased risk of medical complications as the result of pregnancy (Cameron et al., 2020). Standards of care for Preeclampsia during pregnancy for high-risk women at high risk of receiving diagnoses of preeclampsia or related pregnancy-related complications suggest the daily use of prescribed low-dose aspirin (Chang et al., 2023). Research recommends that women experiencing preeclamptic episodes and other complications seek specialized treatment facilities to reduce the risk of adverse events. Gaps in healthcare access fueling location-based disparities among women experiencing preeclampsia and pregnancy related complications are projected to increase (Hanson et al., 2020)

The Florida Commerce defines a rural county as any county with a population of 75,000 individuals or having a population of 125,000 or less with a bordering county with a population of 75,000 or less (Florida Jobs, 2023). The State Office of Rural Health (SORH) estimates 21,216,924 total residents living in the state, data collected from non-metropolitan counties identify 690,028 or 3.3% of residents living in rural areas. Rural healthcare facilities within the state include 10 critical access hospital, 150 rural health clinics, 95 Federally Qualified Health Centers (FQHCs), and 21 short term prospective payment systems that provide necessary healthcare services (Rural Health Information Hub, 2023). Demographically speaking the average income for rural residents within the state of Florida is currently \$42,188 with a federal poverty rate of 18.9% and indicates nearly 18% of the population lack a high school diploma (Rural Health Information Hub, 2023). According to Florida Health Charts (2023)



the maternal mortality for women living in Florida was 39.3 per 100,000 live births in 2021, encompassing maternal death rates within counties across the entire state.

The March of Dimes (2023) highlights 0.1% of babies were born to women living within rural counties in Florida, while 0% of maternity care providers practice within these settings. Rural residency in Florida can contribute to healthcare for expecting mothers experiencing community level barriers. In comparison to the U.S. average (32.6%) 19.4% of counties are classified as maternity care deserts, while also indicating 10.8% of women that have no access to birthing hospitals within a 30-minute driving period (March of Dimes, 2023). Safeguarding access to quality care for this population, including integrating obstetric specialists, is crucial for women in underserved locations to manage chronic medical conditions (Hao et al., 2019). Rural pregnancies account for 1.1% of all births in Florida, between 2020 and 2019 2,272 infants were born in maternity care deserts. A historical context of preeclampsia and related conditions identifies health-related risk factors that may include but are not limited to increased risk of maternal comorbidities and chronic conditions such as kidney disease, hypertension, and obesity (Phipps et al., 2019).

An analysis of Healthcare Cost and Utilization Project (HCUP) data from 2005-2014, identifies women living in poor rural locations have experienced elevated rates of preeclampsia and pregnancy-related complications when compared to more urban settings. This finding highlights elevated rates for women by nearly 20%, from 44.3 to 53.2 per 1,000 deliveries in 2014 (Fingar et al., 2017). Research trends show a steady decline in the prevalence of infant and maternal mortality rates in the past quarter century, providing consistent progress towards improving measures of acute and preventative healthcare affecting this population (Saluja, 2021). Although these advances have improved overall knowledge effective treatment for pregnancy related complications over time, there are several gaps within the literature which does not account for differenced in rural-urban hospital readmissions during pregnancy (Lee et al., 2015). Due to this limitation within research, women experiencing pregnancy-related conditions in underserved populations may be at increased risk of being admitted to the hospital as well as

incurring a significant increase in medical costs (Chang et al., 2023). This study aims to assess the rate of readmission for preeclampsia and pregnancy related complications among women living in maternity care deserts.

## **1.2 Problem Statement**

The U.S. maternal mortality rate has extensively increased over the past 30 years. Previous research identifies an increase of 10.2 deaths per 100,00 between 1989 and 2018 (Hirshberg et al., 2017). Hypertensive Disorders during and after pregnancy disproportionately affect minority women living in rural settings (Cunningham et al., 2018). Although procedural interventions and increased monitoring have been more widely adopted in recent years, diagnoses of pregnancy-related hypertension has been coined as a prominent risk factor for negative health outcomes among women and children (Cameron et al., 2020). The diagnosis, management, and treatment of preeclampsia during and after pregnancy has implications affecting patients across the lifespan, causing rural mothers to experience an increased risk of cardiovascular comorbidities such as stroke and end-stage renal disease; potentially resulting in death (Cunningham et al., 2018).

The research question aims to assess the diagnosis, management, and treatment of preeclampsia during and after pregnancy with the objective of assessing readmission rates for mothers experiencing complications within underserved populations, through an analysis of state hospital data and heat mapping technology.

## **1.3 Does Rural Residency Impact rural Health Outcomes During and After Pregnancy**

The objective of this study is to assess the readmission rates of mothers experiencing preeclampsia and hypertensive complications after delivery in medically underserved populations through an assessment of the state hospital admission data.

- Does rurality contribute to increased rates of preeclampsia and pregnancy related

hospitalization rates, through the analysis of ICD-10 codes to be determined from select mother's final delivery record?

- What is the role of rural residency on maternal health?
- What factors are associated with preeclampsia

#### **1.4 Population**

Rurality can be described as a geographic location with siloed population sizes, limited access to resources, and limited commercial development (U.S. Census Bureau, 2016). Limited access to healthcare in rural locations can have deleterious impacts on population health outcomes, and national policies including the Patient Protections and Affordable Care Act of 2010 aimed to assist in addressing health disparities experienced among rural populations by providing added financial support, expansion Medicaid coverage, and added support for rural hospitals (Douthit et al., 2015).

Populations of women living in rural settings face unique obstacles due to their geographic location and availability of healthcare access. According to the American College of Obstetrics and Gynecologists (ACOG), women living in rural areas have increased adverse health outcomes when compared to their urban counterparts, highlighting 22.8% of women in the United States living in rural settings (ACOG, 2014). Women of minority and ethnic background living in more rural areas are disproportionately affected by chronic illnesses across the lifespan and during pregnancy, increasing health disparity gaps, hospital readmissions, and maternal mortality (Fingar et al., 2017). Minority women in rural areas experience unique access barriers which can greatly contribute to the disease burden. Preexisting risk factors for preeclampsia and pregnancy related complications include age, race ethnicity, multiple births, the diagnosis of renal disease which increases the risk of maternal mortality (Cameron et al., 2020). These economic and socio-deficiencies are depicted by decreased access to health care providers, complex sociodemographic experiences, culture, and infrastructural racism creating healthcare barriers and medical silos for minority residents.

## 2 CHAPTER II SCOPING LITERATURE REVIEW

Preeclampsia and related hypertensive conditions can be defined as a medical condition which affects blood pressure of women during pregnancy for up 12-months post-partum (ACOG, 2022). This pregnancy related complication affects nearly 10% of all pregnancies and was responsible for nearly 6.4 million hospital readmissions between 2013-2014 (Mogos et al., 2018). Preeclampsia can develop within a patient with little warning, potentially causing negative health effects that can advance quickly creating life threatening problems for both women and children (Rana, et al., 2019). The onset of preeclampsia can be progress quickly creating health adversities for both women and children across the lifespan including issues of pre-term birth, blood pressure management, and increased rates of hospital readmissions (Sharma et al., 2020). Research shows that hypertensive disorders are responsible for more cardiovascular related deaths than any other heart related illnesses, citing it as the third leading cause of death among women and children worldwide (Ackerman et al., 2023, Ghulmiyyah et al., 2012).

In the United States, hypertensive medical complications such as preeclampsia are among the most frequent challenges experienced by reproductive age women (CDC, 2020). Increased rates of pregnancy-related hypertensive disorders in the United States have only contributed to the medical burden of women in both rural and urban settings (Cameron et al., 2020). During the past decade, pre-eclampsia and pregnancy related complications have accounted for birth-related complications for nearly 80,000 births and doubling prevalence rates between 2007-2018 (Cameron et al., 2020). Location-based disparities in rural settings has greatly increased within the U.S. fueling the increase, accounting for a 9% increase in the probability maternal mortality and morbidity for deliveries in rural settings (Harrington et al., 2022). Further research studies confirm that reproductive aged women living in geographical areas with limited resources, are at an increased risk of developing preeclampsia when compared to women living in more urban areas (Poon et al., 2019).

Health disparities and healthcare access has been a major issue affecting rural areas across the United States (Bruce et al., 2021). Although access to care in rural locations has gain increased attention in recent

years, persistent barriers has stalled progression to address this issue. Rural patients seeking care experience increased obstacles to accessing care when compared to their urban counterparts despite legislative and policy-based efforts (Solnim et al., 2020). Limitations of healthcare access among rural residents are mainly associated with the closure of rural hospitals (Banard et al., 2022). Research conducted by Banard et al (2022) further highlights obstacles experienced in rural counties by highlighting major catastrophic events such as the COVID-19 Pandemic. The long-term ramifications of the COVID-19 pandemic on rural health access has not been completely assessed at this time, however rural hospital closures have only increased economic strain affecting the financial and operational viability of healthcare infrastructure, staffing shortages, and increased travel time to access care for rural patients (Germack et al., 2019).

Individual societal and economic factors along with the impact of hospital closures in rural settings have shown to have major implications on the status of rural patient population (Holmes et al., 2006). Vulnerable populations of rural health residents face unique challenges affecting their ability to access necessary healthcare services including poverty, limited access to transportation and internet services, limited familial support, and limited educational achievement (Barnard et al., 2022). Within the past ten years alone the United States has overserved the closure of over 100 hospitals in rural settings, accounting for an increase in patient travel time from 3.3-24.2 miles (Government Accountability Office, 2020, Sheps et al., 2019). Detailed reports provided to the Government an Accountability Office (2020) also highlight noticeable gaps among available rural healthcare providers, indicating a disparity within rural counties that experienced hospital closures, citing a decline of providers from 71.2-59.7 per 100,000 residents between 2012-2017.

Limited research on this topic examining the closure of hospital-based obstetric care services has not been widely explored in the literature (Pfundtner et al., 2013). The loss of hospital obstetric services in rural settings has created access barriers for residents in rural areas to obtain adequate pre- and post-natal care even though childbirth is the most common reason for hospitalization in the United States (Hung et

al., 2016). Recent closures of rural obstetric units and entire hospitals have exacerbated concerns about access to care for more than eighteen million women of reproductive age living in rural America (Hung et al., 2017). Access and quality of services could also contribute to this disparity. According to Harrington et al., (2023), rural hospital deliveries accounted for 1 of every 62 births in the United States in 2017, potentially contributing to adverse maternal health outcomes. Although the reasons for this disparity are likely multifaceted, highlighting previous research showing a decrease in hospital-based obstetric services between 2014 and 2018 in rural counties (Kozhimannil et al., 2020).

Although, efforts to improve screening, monitoring, and treatment protocols, health disparities continue to increase among this group of women in the last decade, ultimately creating a causal association towards rates of infant and maternal mortality (Cameron, 2020). Closure of rural Labor & Delivery (L&D) units can impact timely access to hospital-based obstetrical care (Radke et al., 2023). Increased travel times for mothers located in rural settings to access prenatal care has been associated with increased risk of adverse health outcomes such as: pre-term births, low birth weight, and mortality (Petersen et al., 2019). In the United States, 18 million reproductive aged women currently reside in rural counties, highlighting nearly half a million women that deliver their children in rural hospitals every year (Census Bureau, 2017). Hospital closures including labor and delivery unit in rural areas have resulted in access limitations within rural populations (0%-0.97%), inhibiting patients the ability to access healthcare access within a 15-minute radius (McCarthy et al., 2021). Hospital labor and delivery unit closures within increasingly rural areas can have major implications on maternal and infant health outcomes.

Research assessing Labor and Delivery units in North Carolina highlights rural closures in the state disproportionately affected Medicaid consumers (Sullivan et al., 2020). The loss of necessary Obstetric service loss was most frequently observed in rural counties, accounting for 3.5% overall lost services (Kozhimannil et al., 2020). This retrospective analysis also indicates that 68.7% of rural counties included within the study never had access to adequate obstetric services between 2014 to 2018 (Kozhimannil et al., 2020). In rural area pregnant women have an elevated risk of hospitalization in rural settings,

accounting for the increased prevalence of preeclampsia-related conditions when compared to counterparts living in urban settings (Harrington et al., 2019). Operational challenges such as staffing shortages, low occupancy rates, outdated facilities, and market changes can create a burden on a hospital's long term financial viability (Diaz et al., 2020). Limitations of this study include potential miscoding of adverse maternal outcomes on birth and death certificates as well as the potential for variation in the threshold for ICU admission between hospitals. Nearly 55% of rural counties in the U.S. reported an increase in emergency room deliveries in 2014, citing deficiencies in hospital-based obstetric services (Kozhimannil et al., 2020). Current research shows that women of Black and Hispanic descent, have shown women to have substantial risk of experiencing preeclampsia and pregnancy-related conditions when compared to the rates of their racial counterparts (Lee et al., 2015). Sociodemographic factors that can have a synergistic influence on healthcare outcomes include increased rates of obesity, limited access to affordable housing, increased prevalence of smoking, and decreased level of education (Nighbor et al., 2018, Saint et al., 2020, Trividi et al., 2015).

A retrospective study examining a national sample of pregnancy readmission from 1994-2011, highlights elevated readmissions for pregnancy related hypertensive disorders which increased from 0.8 to 1.6 per 10,000 pregnancy hospitalizations (103%) (Leffert et al., 2015). These results are a stark contrast to the average readmittance for other disorders showing 2.2 to 3.2 per 10,000 pregnancy-related hospitalizations (47%) of pregnancies included in this cross-sectional study according to Leffert (2015). The effect of pregnancy related complications nationwide has the as estimated the care cost of women and infants at \$2.18 billion, including care for women and premature infants (ACOG Practice Bulletin, 2020).

Preeclampsia and pregnancy related conditions continue to disproportionately impact women in rural locations. Results from a study of delivery hospitalizations involving preeclampsia and eclampsia from 2005-2017 highlight that preeclampsia diagnoses were 15% higher among Medicaid deliveries (41.2 per 1,000 deliveries (Fingar et al., 2017). The same analysis shows indications of the highest rates of preeclampsia was observed among women residing among the poorest zip codes in more southern areas

in 2005 and 2014 (Fingar et al., 2017). This may be due to variances in healthcare access among preeclampsia research in rural areas identify a plethora of limitations to access adequate pre- and post-natal services. Associations of maternal hospitalizations for patients experiencing preeclampsia and other complications have not been widely analyzed within available literature.

Pregnancy-related hypertensive disorders such as preeclampsia are the leading cause of hospital readmission post-delivery, creating a crippling gap of health disparities among rural and urban mothers, nearly doubling rates of diagnosis in the last decade (Clapp et al., 2016, Cameron et al., 2020). Additional socioeconomic factors and comorbidities such as level of education, proximity to healthcare access, level of insurance, and transportation limitations have created an increased risk of postpartum readmission among this population (DiToso et al., 2021). Prior research examining health disparities and the impact of hypertensive disorders among rural geographic locations highlights care access, rurality, and varying circumstances impacting the Social Determinants of Health (SODH) (Sharma et al., 2020). Research highlighting maternal mortality in urban and rural locations indicate an elevated risk of pregnancy-related death for mothers residing in less populated areas (Merkt et al., 2021). Available literature provides research highlights the need for more information and suggestions for future studies assessing length of stay, care access, potential interventions, and the overall impact of socioeconomic factors regarding this topic.

The association of hospital readmissions and diagnosis of preeclampsia and pregnancy-related conditions is unknown, however existing gaps within research suggests an unidentified correlation between post-delivery management and increased length of stay post-delivery (Wen et al., 2020). Previous retrospective research included the use a plethora of secondary data bases such as the Pregnancy Mortality Surveillance System, the Healthcare Cost and Utilization Project (HCUP), and Health Data Organization's All Payer Claims Data for means of analysis. Studies assessing large claim state data aimed to identify potential indicators that could potentially contribute to the access to care, prevalence, and treatment of hypertensive disorders resulting in hospitalization during and after pregnancy. Results



within the studies identified several key factors of interest that could be a catalyst for preeclampsia diagnosis for at risk women living in rural counties. Factors include age, geographic location, hospital type, current diagnosis, delivery type, additional comorbidities, distance from obstetric care, and length of stay were considered within previous research studies. Existing limitations examining the direct correlation of rural-urban hospital readmission for preeclampsia and other related conditions have still yet to be studied (Lee et al., 2015).

Minority women have an increased risk of mortality from preeclampsia after major birthing events which significantly elevates the possibility of experiencing added birth related complications such as cesarean section (C-section), renal failure, and premature birth (Fingar et al., 2017). The importance of understanding the underlying implications of limited access to necessary obstetric services for women delivering in rural settings. This analysis can provide further insights into complex research facets within analytical data that closely associate with preeclampsia readmissions rural settings and future implications for methods of intervention. Results of this analysis aims to contribute to the future direction of maternal health research by highlighting the current impact of preeclampsia and implications for rural mothers across the lifespan.

### **3 CHAPTER III METHODOLOGY**

#### **3.1 Research Design & Hypothesis**

This retrospective archival data analysis will incorporate the use of secondary hospital discharge data from the state of Florida. The data used will be taken from the HCUP SID database, sponsored by the Agency for Healthcare Research and Quality (AHRQ), which collects records of United States hospital stays and discharge summaries from 2011-2017. This study will use inpatient records from non-federal Florida hospitals to further explore preeclamptic trends extracted from the Florida Agency for Healthcare Administration. Using this data, a retrospective cohort analysis will be used to explore how rurality

affects hospital readmission among post-natal women living in rural zip codes post-delivery using a logistic regression model, Chi Squares, and T-Tests to statistically analyze recorded data.

Binary outcomes were assessed using a multivariable logistic regression to highlight relational associations between preeclampsia readmission and rurality within the state of Florida. Elements within the database are comprised of patient variable data encompassing records of specific treatments, procedures, and payment sources related to hospital admission and discharge. Identification of preeclampsia cases will be selected using specific DRG & ICD-9 codes within rural mothers' final delivery records for hospital readmission for any cause identified in *figure 2*. This quantitative study will include 1-year of hospital admission records from 2019 to observe rates reflected prior to the COVID-19 pandemic. Methods of data extraction and construction will be performed by Comparative Effectiveness Data Analysis Resource (CEDAR) faculty at the Medical University of South Carolina.

Patient data included within the analysis will focus on time of readmission for preeclampsia and other pregnancy related conditions, highlighting the first 30 days after pregnancy and 5- months post-delivery. The period of study will be inclusive of all extracted data for rehospitalization for any reason. This analysis will incorporate data extracted from 276 rural healthcare facilities located in rural counties in the state of Florida (*Appendix A*). Currently, Florida is home to 276 rural health care facilities, with less than 2% (1,076) of practitioners and physicians having direct care facilities in rural Floridian counties according to the U.S. Census Bureau (2023) and the Florida department of Health (2022). Within this analysis, available 2018 HCUP data from the state of Florida were used to further explore rates of hospital readmissions corresponding to appropriate preeclamptic ICD-9-CM diagnoses to identify any associational correlations between rurality and the prevalence of preeclampsia readmission on the state level.

Figure 2. ICD-10 Diagnosis Code Defining Preeclampsia

ICD-10-CM CODE	ICD-10-CM Code Description
O131	Gestational [pregnancy-induced] hypertension without significant proteinuria, first trimester
O132	Gestational [pregnancy-induced] hypertension without significant proteinuria, second trimester
O133	Gestational [pregnancy-induced] hypertension without significant proteinuria, third trimester
O134	Gestational [pregnancy-induced] hypertension without significant proteinuria, complicating childbirth
O135	Gestational [pregnancy-induced] hypertension without significant proteinuria, complicating the puerperium
O139	Gestational [pregnancy-induced] hypertension without significant proteinuria, unspecified trimester
O1400	Mild to moderate pre-eclampsia, unspecified trimester
O1402	Mild to moderate pre-eclampsia, second trimester
O1403	Mild to moderate pre-eclampsia, third trimester
O1404	Mild to moderate pre-eclampsia, complicating childbirth
O1405	Mild to moderate pre-eclampsia, complicating the puerperium
O1410	Severe pre-eclampsia, unspecified trimester
O1412	Severe pre-eclampsia, second trimester
O1413	Severe pre-eclampsia, third trimester
O1414	Severe pre-eclampsia complicating childbirth
O1415	Severe pre-eclampsia, complicating the puerperium
O1420	HELLP syndrome (HELLP), unspecified trimester
O1422	HELLP syndrome (HELLP), second trimester
O1423	HELLP syndrome (HELLP), third trimester
O1424	HELLP syndrome, complicating childbirth
O1425	HELLP syndrome, complicating the puerperium
O1490	Unspecified pre-eclampsia, unspecified trimester
O1492	Unspecified pre-eclampsia, second trimester
O1493	Unspecified pre-eclampsia, third trimester
O1494	Unspecified pre-eclampsia, complicating childbirth
O1495	Unspecified pre-eclampsia, complicating the puerperium
O1500	Eclampsia complicating pregnancy, unspecified trimester
O1502	Eclampsia complicating pregnancy, second trimester
O1503	Eclampsia complicating pregnancy, third trimester
O151	Eclampsia complicating labor
O152	Eclampsia complicating the puerperium
O159	Eclampsia, unspecified as to time period
O161	Unspecified maternal hypertension, first trimester
O162	Unspecified maternal hypertension, second trimester
O163	Unspecified maternal hypertension, third trimester
O164	Unspecified maternal hypertension, complicating childbirth
O165	Unspecified maternal hypertension, complicating the puerperium

O169	Unspecified maternal hypertension, unspecified trimester
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Source: Healthcare Cost and Utilization Project (HCUP) Statistical Brief

**3.2 Specification of Variables**

Variables of interest within this quantitative study will include the analysis of hospital data collected between 2011-2017. Pregnancy related complications are exacerbated by hypertension complications during pre- and postnatal stages of delivery. Among the extracted hospital admission data set, a subset of admissions that are reasonably related to preeclampsia, DRG & ICD-9 codes. The following independent and dependent variables for expecting mothers were considered during the methods development. Independent variables that will be included as confounding factors include: 1) Age (Ranging from 15-45 years of age or age in years at admission), 2) Sex (Female), 3) Race (African American, Hispanic, White and Other), 4) Level of Insurance, and 5) Hospital Readmission for any reason. Additional independent variable of interest that will be used within the analysis includes 1) Insurance status, 2) Access to transportation and 3) Rurality. Variables for education and within this population are not included within the HCUP dataset. The race variable is structured to compare everyone within this data set against other racial categories. Dependent variables include outcomes for women post-delivery involving 1) rehospitalization due to preeclamptic episodes and pregnancy associated complications and 2) Maternal Mortality. Limitations with data used in this analysis include the possibility of inaccurate coding misclassifications by providers when assigning patient ICD- 10 codes upon hospital admittance for preeclamptic episodes.

**3.3 Data Set Description**

The Healthcare Cost and Utilization Project Database (HCUP) is a national inpatient database of hospital care which records health information health services and inpatient stays across 49 States and the District of Columbia. This database has been used to explore and analyze the delivery of care and impact

of care on patient outcomes up to the national level. Samples within this study will be pulled based on the identification of ICD-10 codes collected from the HCUP database to assess readmissions of mothers experiencing preeclampsia or pregnancy related illnesses pre- and post-delivery. The data set encompasses software that allows for the historical research of hospital admissions, including patient statistics, clinical treatments, and medical insurance coverage (Agency for Research and Healthcare Quality, 2023). This study will examine the collection of medical data from 2019 from the state of Florida which will be used to further explore relations to preeclampsia readmission for any reason to identify significant trends among rural women over time. State data from Florida was selected due to its robust size and inclusion of readmission data from vast specialty units. This data set also includes diverse demographic information with a comprehensive inclusion of readmission and preeclampsia related data to better highlight variables of interest compared to other states.

### 3.4 Variables of Interest

Variables of interest within this quantitative study will include the analysis of hospital data collected between 2011-2017. As of 2020, thirty-three counties meet the statue of rurality in the state of Florida shown in (*Appendix C*) highlighting total population of each county with 100 persons or less per square mile (U.S. Census Bureau 2020). Variables to be included as confounding factors will include descriptive variables encompassing data depicting women's age, race (White, Black, Hispanic, and Other), geographic location, and insurance level as highlighted in *figure 2*. The following independent variables will provide definitions that were selected from the HCUP Data Dictionary in efforts to reflect descriptive statistics for retrospective data analysis. The sex of patients will be represented by the NIS description for indicator FEMALE, all other representations of gender will be set to missing. The age of patients will be represented by the NIS description labeled AGE variable depicts the age in years at admission for patients (0-124) among collected patient records beginning in 2004.

Demographic data indicating race indicated by NIS definition will be shown as RACE which provides descriptive statistics for patients within the state of Florida, results for Native America and Asian or Pacific Islander will be categorized as Other within the analysis. Ethnicity will not be used within the analysis. Variables categorized under level or education and level of insurance were not clearly defined within the HCUP data dictionary for the state of Florida. Pregnancy related complications exacerbated by hypertension complicating pregnancy/ birth complications after ectopic/molar pregnancies, other complications in pregnancy, and complications specified during childbirth are the outcome variable and will be made dichotomous. Among the extracted hospital admission data set, a subset of admissions that are reasonably related to preeclampsia, ICD-9 codes will be identified and used for further study. Specific dependent variables of interest for this analysis will include preeclampsia, hospital location & teaching status, hospital location, and length of stay upon readmission as defined in (figure 4).

Figure 4. ICD-9-CM Variables Defined by HCUP Data Dictionary

Variable	ICD-9-CM Code	Definition
Age	AGE	Age in years at admission
Race	RACE	Race/ethnicity of patient
Insurance Level	APSDRG	All-Payer Severity-adjusted DRG
Rural Vs. Non-Rural County	HOSP_LOCATION	Location (urban/rural) of hospital
Preeclampsia (Hypertension)	CM_HTN_C	AHRQ comorbidity measure for ICD-9-CM codes: hypertension (Combine uncomplicated and complicated)
Hospital Location/Teaching Status	HOSP_LOCTEACH	Location/teaching status of hospital

Hospital Location	HOSP_Location	Classification of urban or rural location
In-Hospital Birth	HOSPBIRTH	ICD-9-CM diagnosis indicates in-hospital birth
Length of Stay Cleaned	LOS	Length of hospital stay

Figure 5. Variable Description

Construct	Variable	Range
Quality of care	Readmission within 30 days for hypertension following childbirth	Yes/No
Hospital Characteristics	Rurality	Yes/No
	Bed size	
	Critical Access Hospital Rural Healthcare Clinic Federally Qualified Health Center Short Term/PPS Hospital in Rural Area	
<b>Patient control factors</b>	Sex	Female
	Age (In yeas at admission)	14-18
		19-25
		26-35
		36-45
		50+
	Race	Black White Any Ethnicity Other
Insurance Coverage	Insured Uninsured Self-Pay None	
Access to Transportation	Yes/No	
Rural Vs. Non-Rural Counties	Yes/No	

Figure 6. Rural Counties in Florida by ZIP Code

Rural Counties (2020 Census) 100 Persons or less per square mile		Range
Population Size N=	County	

28,259	Baker	Yes/No
28,303	Bradford	Yes/No
69,698	Columbia	Yes/No
13,648	Calhoun	Yes/No
33,976	DeSoto	Yes/No
16,759	Dixie	Yes/No
120,932	Flagler	Yes/No
12,451	Franklin	Yes/No
43,826	Gadsen	Yes/No
17,864	Gilchrist	Yes/No
12,126	Glades	Yes/No
14,192	Gulf	Yes/No
14,004	Hamilton	Yes/No
25,327	Hardee	Yes/No
39,619	Hendry	Yes/No
101,235	Highlands	Yes/No
101,235	Holmes	Yes/No
47,319	Jackson	Yes/No
14,510	Jefferson	Yes/No
8,226	Lafayette	Yes/No
42,915	Levy	Yes/No
7,974	Liberty	Yes/No
17,968	Madison	Yes/No
90,352	Nassau	Yes/No
39,664	Okeechobee	Yes/No
73,321	Putnam	Yes/No
43,474	Suwannee	Yes/No
21,796	Taylor	Yes/No
16,147	Union	Yes/No
33,764	Wakulla	Yes/No
75,305	Walton	Yes/No
25,318	Washington	Yes/No

### 3.5 Data Analysis

First descriptive analyses of each variable will be run to ensure normality of the data. Then, logistical regression, a data analysis technique used to evaluate the relationships of dependent and independent variables, will be used. This analysis, given the binary outcome variable (preeclampsia readmission), a logistical regression approach will be used to assess the



rate of hospitalization for preeclampsia and other adverse complications, while controlling for factors such as race, age, access to transportation, education level, and insurance type. The use of logistic regressions, Chi Squares, and T-tests were used to explore variables of interest nested within the dataset to evaluate relationships between preeclampsia readmission and rural location while controlling for SODH confounders using SAS software. P-values <0.05 will provide evidence of possible associations among variables.

### **3.6 Protection of Human Subjects**

The Medical University of South Carolina (MUSC) has established policies, procedures, and programs for the review of human subject research to promote the ethical conduct of research, safeguard the integrity of and protect human subjects, maintaining strict compliance with regulatory standards. MUSC investigators are granted the privilege of using human subjects under assurance to the government that research conducted at MUSC complied with all federal and local regulations protecting individuals involved in human subjects' research. The Healthcare Cost and Utilization Project (HCUP) data use agreement safeguards the confidentiality of patients, physicians, and healthcare institutions, protecting the privacy of the individuals and institutions that are featured within this study. The research conducted within this analysis will be completely de-identified and is exempt from the requirements of IRB related to human subjects.

## **4 CHAPTER IV RESULTS**

### **4.1 Health Outcomes for Rural Mothers**

In this study, 46,841 women who gave birth in Florida and were between the ages of 18 and 45 during 2019 were included within the analysis. The average age of the sample was 29.1 years. Of the total population of women, 1,675 had a diagnosis of pre-eclampsia, 1,291 were

readmitted within thirty days of delivery. These are shown in table 1. Among rural residents 198 (11.28%) mothers were observed to have a preeclampsia diagnosis, in comparison to 5,227 (11.67%) of mothers residing in urban counties, and this relationship was not statistically significant. When assessing rurality and its effect on preeclampsia, this analysis was not shown to be statistically significant  $p=0.8505$ . When examining the percentage of minority patients in the population, 10,692 were black, 21,608 were White, 2,831 recorded their race as Other. Results of this analysis show that Black women had an increased frequency of being diagnosed with preeclampsia during their gestational periods when compared to other ethnic groups at a rate of 14.18%, results did not show a statistically significant p-value ( $p<.0001$ ). Further analysis of the data indicates 11.68% of other race mothers, 9.89% of Hispanic mothers, and 9.57% of white mothers living in rural Florida counties were diagnosed within this period which was not statistically significant ( $p<.0001$ ). Ethnicity was not included within the parameters of this study.

Table 1: Descriptive Statistics for All Births in Florida Age 18-45			
N=46,841	Preeclampsia	Not Preeclampsia	p-value
Age	29.1 ± 6.0	29.2 ± 5.6	
<b>Preeclampsia Rural</b>	198 (11.82%)	1,477 (88.18%)	.08505
<b>Preeclampsia Urban</b>	5,271 (11.67%)	39,895 (88.33%)	.08505
<b>Percent Minority:</b>			
Black	1,516 (14.18%)	9,176 (85.82%)	<.0001
Hispanic	1,158 (9.89%)	10,552 (90.11%)	
White	2,524 (11.68%)	19,084 (88.32%)	
Other	271 (9.57%)	2,560 (90.43%)	

<b>Insurance Status:</b>			
Medicaid	2,587 (11.68 %)	19,565 (88.32%)	0.0852
Medicare	41 (9.79 %)	378 (90.21%)	
Private	2,622 (11.84 %)	19,519 (88.16%)	
Uninsured	62 (8.83 %)	640 (91.17%)	
Other	157 (11.0 %)	1,270 (89%)	
<b>30-Day Readmission</b>			
Any Readmit	813		
Preeclampsia Readmit	478		
<b>Total</b>	1,291		

Table 2 provides a descriptive comparison of rural and urban mothers included within the analysis that gave birth in the state of Florida assessing the following categories including: insurance status, length of stay, total cost, and zip code status. Insurance status among the population that were included in the analysis included Medicaid, Medicare, Private Insurance, Uninsured, and other forms of coverage. A total of 2,587 (11.68%) of Medicaid patients, 41 (9.79%) of Medicare patients, 2,622 (11.84%) Private insured patients, 62 (8.83%), and 157 (11.%) of patients who had other forms of coverage were observed. This analysis yielded a p-value of 0.0852 which is not statistically significant. The average length of stay for preeclampsia diagnosed patients living in rural settings was 3.7 days, compared to an average of 2.65 days for mothers without preeclampsia. In 2019, the average total cost for women with preeclampsia was \$6,441.44 in contrast to the average total cost of \$4,625.28 for patients without a preeclampsia,

yielding a \$1,816.16 cost difference. County zip codes within the state of Florida accounted for 46,520 persons with 321 missing frequencies.

A rural county in the state of Florida is described as a location with a population of 75,000 or less or it has a population of 125,000 or less sharing a border to a county of 75,000 persons or less. The analysis for counties in the dataset were distributed among poorest and richest zip codes according to the median household income. Florida counties that were included in the analysis were disseminated among four categories, with category one including the poorest county zip codes and category four encompassing the richest county zip codes. Table 2 similarly indicates a total of 5,424 mothers with preeclampsia across poor and rich counties were included in the data set. Results of this analysis indicated 1,924 (12.12%) of the total number of women with preeclampsia were residing in poor counties in 2019, compared to 408 (10.49%) of women living within the wealthier counties. This inference suggests that women living in lower income counties are disproportionately affected by preeclampsia, and this statistical test was significant ( $p=0.0105$ ).

Table 2 : Characteristics of Rural Mothers with Preeclampsia Diagnosis			
<i>N= 46,841</i>	<b>Rural Preeclampsia (5,469)</b>	<b>Not Rural Preeclampsia (41,372)</b>	<b>p-value</b>
Length of Stay (Cleaned)	3.7 Days	2.65 Days	
Total Cost	\$ 6,441.44	\$4,625.28	
Readmission for Preeclampsia Length of Stay	156 (2.23-2.13)	193 (2.26-1.66)	

Readmission for Preeclampsia Cost	156 (\$3,887.50-\$3,706.40)	193 (\$4,347-\$4,940.85)	
Length of Stay for Other Readmission Types	85 (3.27-3.05)	399 (3.21-3.62)	
Cost for Other Readmission Types	85 (\$6,830-\$6,222.23)	399 (\$7,416.52)	
Zip Code Status:			
Poorest Zip Codes 1	1,924 (12.12%)	13,950 (87.88%)	0.0105
Richest Zip Code 4	408 (10.49%)	3,481 (89.51%)	

**4.2 Preeclampsia Readmissions**

Table 3 highlights a total of 156 (2.85%) of rural women experienced hospital readmittance to receive treatment for preeclamptic episodes within this population. This result is compared to 193 (0.47%) urban residents with preeclampsia diagnosed patients who were also readmitted for preeclampsia, indicating statistical significance of (p=<.0001). A further analysis of the data accounted for mothers readmitted for unrelated reasons resulting in a total of 85 (1.55%) who were treated for unassociated complications, also emphasizing a statistically significance association with of 30-day readmission rates for preeclampsia and other pregnancy related hospitalizations (p=<.0001). When examining rates of readmissions for all other reasons, results indicate a total number of 237 (4.33%) rural mothers with preeclampsia were hospitalized in contrast to 585 (1.41%) within this time period who were not readmitted during this period. This highlights a significant difference among results from this analysis (p-value =<.0001).

Table 3: Preeclampsia Readmissions			
<i>N=46,841</i>	Preeclampsia Rural	Non-Rural Preeclampsia	p-value
<b>Rural Preeclampsia Readmission</b>	156 (2.85%)	5,313 (97.15%)	<.0001
<b>Urban Readmission Preeclampsia</b>	193 (0.47%)	41,179 (99.53%)	
<b>Unrelated Readmission</b>			<.0001
Yes	85 (1.55%)	5,384 (98.45%)	
No	399 (0.96%)	40,973 (99.04%)	
<b>Any Preeclampsia readmission</b>			<.0001
Yes	237 (4.33%)	585 (1.41%)	
No	40,787 (98.59%)	5,232 (95.67%)	

**4.3 Odds Ratio Estimates**

The results of table 4 indicate that women diagnosed with preeclampsia are five times more likely to be readmitted to the hospital 30-days after birth compared to women without preeclampsia (OR= 5.994, CI (4.832-7.424)). In reference to age, mothers between the ages of 18-45, diagnosed with preeclampsia had a slightly increased likelihood of being readmitted for care within the 30-day time period compared to other urban mothers without preeclampsia (OR=1.053, 95% CI(1.034-1.073)). Odds ratios for race indicates black mothers are 3.4 times more likely to be readmitted for preeclampsia complications compared to white mothers (OR=3.371, 95%CI (2.570-4.422)). Overall, findings indicate that significant risk of readmission is present for rural mothers to be admitted within 30-days of delivery for readmission for preeclamptic episodes compared to white rural.

Insurance status among this population includes Medicaid, Medicare, Private insurance, and mothers with other forms of payment. Rural mothers with Medicaid coverage have a 0.6 risk of being readmitted for preeclampsia and pregnancy related complications compared to uninsured mothers with preeclampsia (OR=0.645 95% CI (0.282-1.477)). Mothers with Medicare coverage as their primary form of insurance are 1.2 times more likely to be readmitted to the hospital for preeclampsia when compared to uninsured mothers (OR=1.206, 95% CI (0.381-3.817)), with a statically significant p-value of 0.0217. Patients covered by private insurance are less likely (OR=0.787) to experience similar readmission when compared to all Insured consumers (OR=0.787, 95% CI (0.345-1.798)) p= 0.0113.

Results of the odds ratio for classification of estimated median housed income shows a statistically significant difference among mothers living among the assessed zip codes p=0.0263. Mothers living in lower income counties have an increased likelihood of being readmitted within 30-days for preeclampsia and other related complications compared to mother in women in wealthier counties, (OR= 0.863, 95% CI (0.759-0.982)). In the logistic regression in table 4, rural residence was not statistically significant.

<b>Table 4: Analysis of Likelihood estimates for 30-Day readmission</b>		
<b>Variables</b>	<b>OR (95% CI)</b>	<b>p-value</b>
Preeclampsia	5.994 (4.832-7.424)	<.0001
Age	1.053 (1.034-1.073)	<.0001
Black vs White	3.371 (2.570-4.422)	0.0270

Hispanic vs White	1.394 (1.014-1.918)	0.2747
Other vs White	1.717 (1.065-2.768)	0.6571
Medicaid vs Uninsured	0.645 (0.282-1.477)	0.4584
Medicare vs Uninsured	1.206 (0.381-2.351)	0.0217
Other vs Uninsured	0.858 (0.313-2.351)	0.5902
Private vs Insurance	0.787 (0.345-1.798)	0.0113
ZIPINC_QRTL	0.863 (0.759-0.982)	0.0263
Rural	0.696 (0.326-1.486)	0.4233

## 5 CHAPTER V DISCUSSION

### 5.1 Preeclampsia in Rural Settings

Hypertensive disorders pose a tremendous threat to women during and after pregnancy. Studies have indicated that increased rates of preeclamptic diagnoses and rural location contribute to detrimental rates of maternal mortality within this population. This is due to many coexisting factors, demographic challenges, and the receipt of limited or subpar medical care. Other severe economic limitations serve as contributing facts including lack of social support, increased maternal burden, increased specialty hospital closures, structural racism, and discrimination which all contribute to the disease burden within this group (Sharma et al., 2020) (Bryant et al., 2020). Research has shown that the increased rates of preeclampsia and pregnancy related conditions among rural areas have shown major disparities in care and treatment among rural and urban settings. As



previously described within the problem statement it is known that hypertensive disorders adversely affect the health of rural minority women across the life span, affecting rates of rehospitalization during pregnancy and maternal mortality among this population (Cunningham et al.,2018).

The purpose of this research study aimed to identify if rurality had any contribution to elevated rates of preeclampsia and pregnancy related conditions within Florida, and what impact if any did rurality have on the health of resident mothers. According to the results analysis it was found that rural women living in Zip codes with lower household incomes had an elevated risk of 30-day hospital readmission. This suggests a significant correlation among elevated rates preeclampsia readmission 30-days after delivery among rural settings. While examining racial indicators significant findings from the study also indicate strong associations between race and preeclampsia diagnosis. The research findings could suggest that providers may have to increase screening methods among minority women to address the potential risk of preeclampsia development. Results of the study also emphasize a significant correlation among patients diagnosed with preeclampsia and increased rates of 30-day readmission. Findings provided indication that compared to mothers without a preeclampsia diagnosis, preeclamptic rural mothers carried five times the risk of experiencing a hospital readmission one month after giving birth.

After completion of the analysis, it can be suggested based on the evidence of this study that an increase of screening and additional support mechanisms for the management of preeclampsia is needed to address the health disparity of 30-readmission

among black rural women diagnosed with preeclampsia. Preeclampsia screening is currently a standard of practice for all pregnant women and is done by assessing blood pressure levels to improve early detection efforts. Black and minority women have an increased predisposition to preeclampsia diagnoses and are disproportionately at risk of maternal death than any other racial group. Access to improve methods of screening interventions, education, and management in the form of adequate primary care is vital in addressing the incidence and prevalence of preeclampsia and other seriously related complications, potentially resulting in increased adverse health outcomes for this population.

Increased access to necessary post-partum care interventions has shown to improve accessibility and support for mothers after delivery (Taylor et al., 2020). More research is needed to understand many of the underlying factors that contribute to preeclampsia disparities among Black residents. Potential suggestions to address the health disparities gap can include a thorough audit of current postpartum care procedures, increased workforce training opportunities for providers, and improved provider patient support for preeclamptic women. Added layers of support among disproportionately impacted mothers has the potential to assist in ease the burden of disease and lessen the gap among rates preeclampsia readmissions.

## **5.2 Implications for Policy and Practice**

Research has emphasized the importance of access to timely and quality healthcare services during the gestational period can greatly reduce the detrimental hazards of a preeclampsia diagnosis and other pregnancy related complications (National Committee for Quality Assurance, 2023). Hypertensive complications such as preeclampsia has been

indicated as the leading cause of rehospitalization post-delivery in the U.S. between 2004-2016, while current research emphasizes the steady increase in rates of readmission across the county (Clapp et al., 2016). Current research and statistical analysis indicate a strong evidence-based correlation between preeclampsia diagnosis and rehospitalization of women. Early intervention efforts to prevent and monitor preeclampsia is essential to improving maternal health outcomes. The focus of preeclampsia prevention has turned to supporting interventions that increase maternal screening efforts for early detection and treatment planning measures. Although, early clinical screening measures for mothers diagnosed with preeclampsia has improved over time, there has been limited progression among testing and treatment measures surrounding preeclampsia.

Access to necessary care for rural mothers' can potentially have a major contribution on pregnancy-related readmissions and elevated rates of maternal mortality within these areas. According to the American Heart Association many minorities reported experiencing discriminatory exchanges among medical staff and inequities regarding care quality exacerbating patient-physician relationships and overall experience (AHA, 2022). Representation among women of color in all facets of health care have proven to vastly influence patient engagement and satisfaction, support, and physician-patient rapport. This factor along with critical hospital closures, only increases barriers to rural patient health outcomes. Although barriers of care for preeclampsia and pregnancy related conditions still exist across the healthcare continuum, many legislative partnerships have been formed to address socioeconomic factors that may contribute to the increased rise of hospital readmissions.

The Maternal Health Quality Improvement Act (H.R.4995) was passed in September of 2020, providing additional grant opportunities for maternal health initiatives, rural maternal health grants, and increased health-based education opportunities among rural settings. Current policy efforts include the Data to Save Moms Act introduced by U.S. Senator Tina Smith which was signed into law in 2018. This legislative bill has been passed to address maternal mortality rates that disproportionately impact women of color through improvements in data collection and research, community engagement, and investments in cutting edge research among Minority-Services Institutions (Federal Communications Commission, 2023). The Momnibus Act or the Black Maternal Health Momnibus is another form of legislation that has gain steam within the field of maternal health. Led by the Black Maternal Health Caucus, it comprehensively includes nine bills to address the growing maternal health crisis in the United States. Three of the nine bills including: The Kira Johnson Act, The Data to Save Moms Act, and The Impact to Save Moms Act are devoted to the improvement of health quality and equity, address health disparity gaps, and increased support across the continuum of care for mothers.

Policies and programs within the state of Florida currently have been developed to address the growing concern for the safety of mothers and babies across the state, through education-based research fueled initiatives, and data collection efforts. The University of South Florida located in Tampa, is actively collaborating with the CDC and Florida Health boasts the Florida Perinatal Quality Collaborative (FPQC) which is designed to advance perinatal healthcare and across the state with a focus on Mother- Focused Care (MFC) (USF College of Public Health, 2023). This unique collaborative is the only partnership of

its kind within the state, and its goal aims to engage local, state, and national stakeholders to create wrap around services as a quality improvement initiative which impact maternal health outcomes. Sub initiatives within the collaborative include the Postpartum Access & Continuity of Care Initiative (PACC) which has been instrumental in assisting healthcare specialists to engage in the coordination of prompt, risk- appropriate, and culturally inclusive, healthcare services (USF College of Public Health, 2023). These legislative efforts to move the needle of maternal health care throughout the state has not only fostered the implementation of cutting edge maternal and child health programs but has provided tangible educational training tools for providers to appropriately monitor, manage, and educate communities about the increasing concerns of maternal health safety protocols among rural communities.

Another perinatal program which has devoted its services to the support and health of mothers in the state includes REACH UP, incorporated, located in Hillsborough County Florida. This organization provides several research-driven wrap-around services, that place a special emphasis on family wellbeing and birth-related support for mothers in Florida. This multifaceted program aims to thwart the growing concern of maternal deaths in the state through targeting patient literacy and safety initiatives before, during, and after the period of gestation. County and state-based research has shown that the provision of influential programs including GROWTH Doulas, Stress Management, Merck for Mothers, and Pregnancy Medical Home have greatly impacted the maternal mortality outcomes since its inception.

Future aims for the development of policy efforts for preeclampsia and its impact on maternal mortality across the United States has gained vast acknowledgement over the past 10 years. Interventions to prevent preeclampsia or reduce its symptoms have been a topic of interest among current studies. The correlation of factors including exercise, improved nutritional habits, rest, and pregnancy supplements on preeclampsia outcomes have been suggested, however there is no evidence supporting the association among individual factors (Bezerra et al., 2012). There is no cure for preeclampsia, however early diagnosis and increased monitoring are vital to the safety and wellbeing of women and their babies before and after delivery. Current clinical treatments included blood pressure monitoring, urine analysis, and the potential delivery of appropriate hypertensive medications. These efforts are used to assess the functionality of the heart and kidneys and their influence on the status of patient health.

Additional monitoring efforts will also include mothers preeclamptic conditions and its impact on fetal growth and development. Agencies such as the Centers for Disease Control and Prevention, The Preeclampsia Foundation, Council of Patient Safety in Women's Healthcare and several other organizations are using current scientific research to develop policy focused initiatives that aim to improve standards of care and close the gaps of disease burden. Overarching goals of implementation of instrumental healthcare legislation aims to improve health outcomes through increasing awareness of physicians and lawmakers, identify additional factors influencing the diagnosis of preeclampsia across the lifespan, and increase screening and monitoring efforts. Further efforts encompassed by this bill include the facilitation of future preeclampsia investments,

research, the development of new methods of treatment and patient monitoring techniques (Preeclampsia Foundation, 2023). These policy driven initiatives focus heavily on influencing change on the community, state, and national levels.

### **5.3 Limitations**

Limitations of the study include the omission of educational attainment within the data set. The state of Florida did not collect education during hospital admission. The inclusion of descriptive data points such as education as it related to preeclampsia diagnosis and management among rural populations can give great insight into a possible correlation of patient health literacy, engagement, self-advocacy, and individual health behaviors. Access to transportation and or the availability of internet access was also not collected within HCUP dataset and will not be incorporated within the analysis of this study. Among other barriers, ease of accessibility is possibly a grave challenge for rural mothers to overcome. Another potential limitation of this study includes the presence of potential coding errors, which can be due to inadequacies in medical documentation with respect to the collection of the HCUP dataset.

### **5.4 Future Research**

The long-term impact of preeclampsia can affect women and their families throughout the course of their lives. As rates of maternal mortality has vastly increased over the past decade, the implementation of strategic monitoring systems, education-based interventions, legislative efforts, and the provision of quality healthcare should embolden stakeholders to strive to achieve gold standard of care for all mothers. Preeclampsia is one of the most serious pregnancy-related conditions and contributes to the incidence and prevalence of maternal deaths. Although there is no cure for this chronic illness, efforts to minimize impact of preeclampsia through research can assist with better understanding the biological and socio-economic affects that persist with its

diagnosis. Rural women face an immeasurable number of barriers as it related to obtaining consistent and quality perinatal services. This is due to gaps in healthcare access, limited access to cutting edge monitoring tools, provider shortages, and easibility of access.

Research conducted within this study highlight several areas of concern affecting this population which emphasize the dire need to continue research to examining potential causes, risk factors, measures of treatment, and monitoring impacting similar populations. Future research aims should incorporate the inclusion of population data regarding education to better understand the influence of healthcare literacy on preeclampsia management and rehospitalizations. It is equally important to continue to educate at risk communities in rural settings by working to increase access to timely and necessary medical services. Educational awareness among stakeholder, providers, and legislative officials should continue to be provided with research-based information to keep this public health crisis and its detrimental impacts on rural families across the healthcare continuum should continue to fuel efforts of policy-based changes on local, state, and national levels. It is vastly important for organizations to continue pursuing collaborative efforts to engage in preeclampsia research using methods that are specific, measurable, achievable, relevant, and time-based in efforts to treat and manage pregnancy related hypertension.

## **5.5 Conclusions**

Significant findings of this analysis show a total of 156 rural mothers within the dataset were readmitted for preeclampsia treatment during 2019. Women diagnosed with preeclampsia were 5 times more likely to be readmitted to the hospital one month post-delivery. Black rural women living in the state showed considerably increased risk of



being diagnosed with preeclampsia during pregnancy and were 3.4 times more likely to be readmitted within 30-days after giving birth compared to their racial counterparts.

Although insurance status was not shown to be statistically significant within the analysis, majority of women included within the study were consumers of private insurance, with the second most common form of insurance coverage being Medicaid. Findings also indicated that rural mothers incurred a greater total cost of nearly \$2,000 difference for preeclampsia treatment as well as increased length of stay, compared to costs incurred by urban residing mothers. Results revealed that rurality was shown to have a significant influence on 30-day preeclampsia readmission rates among this population, showing a stark statistical difference for rehospitalization of 2.38% among women residing in rural counties compared to urban mothers.

Statistically significant trends for 30-day readmissions indicated 237 rural mothers were treatment for other pregnancy related complications which yielded a 2.92% difference between patients with preeclampsia that were not hospitalized within this period. A logistic regression analysis of zip codes indicates 1,924 women diagnosed with preeclampsia resided within poor Floridian counties in 2019. Results of this analysis accounted for 12% of the population within this dataset indicating that women living in more impoverished counties within the state are disproportionately affected by preeclampsia compared to wealthier zip codes. This provides further evidence that of correlations between rurality and 30-day preeclampsia readmissions. After a complete analysis of the data, it can be inferred that rural women experience greater incidence and

prevalence of preeclampsia diagnoses and have a greater risk of rehospitalization 30-days after delivery compared to urban mothers.

Added elements disease burden along with confounding factors including genetic makeup and geographic locations, and only contributes to the existing disparity gap among this population. Results of this retrospective statistical analysis further emphasizes the importance of maternal and child health research and its overall contribution to increased rates of maternal mortality. Limited access to the dissemination of timely and adequate interventions for rural women experiencing preeclamptic episodes and other pregnancy related complications can greatly impact the risk of maternal and fetal death among these populations. Increased efforts to fund preeclampsia research, educate primary care providers and engage patients about the risk factors and outcomes of preeclampsia can increased policy-based monitoring treatment efforts for areas like those in this study. Future preeclampsia research should aim to explore additional factors including patient educational attainment, provider awareness and monitoring efforts, and efficacy of current monitoring tools and treatment efforts.

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## Appendices

### Appendix A: Florida Rural Healthcare Facilities by County



### Appendix: B

ICD-10-CM CODE	ICD-10-CM Code Description
O131	Gestational [pregnancy-induced] hypertension without significant proteinuria, first trimester
O132	Gestational [pregnancy-induced] hypertension without significant proteinuria, second trimester
O133	Gestational [pregnancy-induced] hypertension without significant proteinuria, third trimester
O134	Gestational [pregnancy-induced] hypertension without significant proteinuria, complicating childbirth
O135	Gestational [pregnancy-induced] hypertension without significant proteinuria, complicating the puerperium
O139	Gestational [pregnancy-induced] hypertension without significant proteinuria, unspecified trimester
O1400	Mild to moderate pre-eclampsia, unspecified trimester
O1402	Mild to moderate pre-eclampsia, second trimester
O1403	Mild to moderate pre-eclampsia, third trimester
O1404	Mild to moderate pre-eclampsia, complicating childbirth
O1405	Mild to moderate pre-eclampsia, complicating the puerperium
O1410	Severe pre-eclampsia, unspecified trimester
O1412	Severe pre-eclampsia, second trimester
O1413	Severe pre-eclampsia, third trimester
O1414	Severe pre-eclampsia complicating childbirth
O1415	Severe pre-eclampsia, complicating the puerperium
O1420	HELLP syndrome (HELLP), unspecified trimester
O1422	HELLP syndrome (HELLP), second trimester
O1423	HELLP syndrome (HELLP), third trimester

O1424	HELLP syndrome, complicating childbirth
O1425	HELLP syndrome, complicating the puerperium
O1490	Unspecified pre-eclampsia, unspecified trimester
O1492	Unspecified pre-eclampsia, second trimester
O1493	Unspecified pre-eclampsia, third trimester
O1494	Unspecified pre-eclampsia, complicating childbirth
O1495	Unspecified pre-eclampsia, complicating the puerperium
O1500	Eclampsia complicating pregnancy, unspecified trimester
O1502	Eclampsia complicating pregnancy, second trimester
O1503	Eclampsia complicating pregnancy, third trimester
O151	Eclampsia complicating labor
O152	Eclampsia complicating the puerperium
O159	Eclampsia, unspecified as to time period
O161	Unspecified maternal hypertension, first trimester
O162	Unspecified maternal hypertension, second trimester
O163	Unspecified maternal hypertension, third trimester
O164	Unspecified maternal hypertension, complicating childbirth
O165	Unspecified maternal hypertension, complicating the puerperium
O169	Unspecified maternal hypertension, unspecified trimester

*Appendix C: Rural Counties in Florida by ZIP Code*

Rural Counties (2020 Census) 100 Persons or less per square mile		Range
Population Size N=	County	
28,259	Baker	Yes/No
28,303	Bradford	Yes/No
69,698	Columbia	Yes/No
13,648	Calhoun	Yes/No
33,976	DeSoto	Yes/No
16,759	Dixie	Yes/No
120,932	Flagler	Yes/No
12,451	Franklin	Yes/No
43,826	Gadsen	Yes/No
17,864	Gilchrist	Yes/No
12,126	Glades	Yes/No
14,192	Gulf	Yes/No
14,004	Hamilton	Yes/No
25,327	Hardee	Yes/No
39,619	Hendry	Yes/No

101,235	Highlands	Yes/No
101,235	Holmes	Yes/No
47,319	Jackson	Yes/No
14,510	Jefferson	Yes/No
8,226	Lafayette	Yes/No
42,915	Levy	Yes/No
7,974	Liberty	Yes/No
17,968	Madison	Yes/No
90,352	Nassau	Yes/No
39,664	Okeechobee	Yes/No
73,321	Putnam	Yes/No
43,474	Suwannee	Yes/No
21,796	Taylor	Yes/No
16,147	Union	Yes/No
33,764	Wakulla	Yes/No
75,305	Walton	Yes/No
25,318	Washington	Yes/No