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When the Costs Outweigh the Benefits: Examining Variations in Nulliparous, Term, Singleton, Vertex and Elective Cesarean Delivery Rates Across the United States, 2016-2020

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When the Costs Outweigh the Benefits:

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ABSTRACT

When the Costs Outweigh the Benefits:

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The overutilization of cesarean deliveries is a major public health issue in the United States (U.S.). The rates of cesarean deliveries have increased substantially from the mid 1990s. Low-risk, defined as nulliparous, term, singleton, vertex (NTSV) pregnancies with no medical indication of need, and elective cesarean deliveries have been implicated as drivers of these increases. Elective cesarean deliveries are NTSV cesarean deliveries in which no trial of labor was attempted. There is a lack of clear rationale as to the noted increases in cesarean delivery rates as the evidence shows that these procedures provide no additional health benefits to mothers or infants. In fact, excessive use of cesarean sections has been associated with poorer health outcomes and quality of care, and higher health care expenditures. The purpose of this dissertation is to examine the current variation in NTSV and elective cesarean deliveries in the U.S., and further to examine the extent to which national trends are mirrored in Appalachia, a region disproportionately burdened by lack of health care resources and poor health outcomes.

A repeated cross-sectional analysis of the prevalence of NTSV and elective cesarean deliveries in the U.S. between 2016 and 2020 was conducted using individual-level vital records data. Differences were examined by rurality and Appalachian designation. Logistic regression and

marginal analyses were used to examine changes in the prevalence of these outcomes over time while adjusting for additional pertinent covariates.

Approximately 25% of NTSV births are delivered via cesarean section, and 37% of those NTSV cesarean deliveries are elective. No practically significant differences in the prevalence of NTSV cesarean deliveries were noted based on rurality or Appalachian designation. However, there were significant variations in the prevalence of elective cesarean deliveries by geography. Rates of elective cesarean deliveries were significantly lower in rural communities compared to metropolitan, or urban, communities. Non-Appalachia had predominantly higher prevalence of elective cesarean deliveries compared to the Appalachian sub-regions. The findings of this dissertation suggest that while variations in health outcomes may be driven by geographic designations, variations in health services utilization are likely driven by other factors, such as institutional and provider characteristics.

DEDICATION

To my family for their unwavering support and faith in me. Thank you.

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Chapter 1. Introduction

Rationale

Approximately 3.7 million babies were born in the United States (U.S.) in 2019 and nearly one in three were born via cesarean delivery (Martin et al., 2021; Osterman & Martin, 2014b). When medically indicated, cesarean deliveries can serve as a life-saving procedure (Kozhimannil, Law, et al., 2013; Roth & Henley, 2014; Sandall et al., 2018). However, when not medically indicated, cesarean delivery can lead to increased risk for short- and long-term health consequences for mothers and infants compared to women who deliver vaginally (Henke et al., 2014; Kilpatrick & Ecker, 2016; Matevosyan, 2015; Mylonas & Friese, 2015; Sandall et al., 2018; Weimer et al., 2019). Cesarean deliveries can influence and dictate subsequent labors and deliveries, as well as lead to higher risk for maternal morbidity and mortality (Matevosyan, 2015; Osterman & Martin, 2014; Sandall et al., 2018). Cesarean deliveries are associated with several major causes of maternal morbidity and mortality, specifically infection, hemorrhage, and anesthetic complications (Roth & Henley, 2014).

It is suggested that the increases in the cesarean delivery rate are being driven by increases in low-risk and non-medically indicated cesarean deliveries (Weimer et al., 2019). A low-risk cesarean delivery is defined as a cesarean delivery in a nulliparous, term, singleton, vertex (NTSV) pregnancy without medical indications (Armstrong et al., 2016; Osterman & Martin, 2014; Weimer et al., 2019). The rate of NTSV cesarean deliveries is a commonly utilized metric for assessing the quality of perinatal health care (Armstrong et al., 2016; Osterman &

Martin, 2014; Weimer et al., 2019). The Joint Commission on the Accreditation of Healthcare Organizations (JCAHO), an independent not-for-profit organization responsible for the evaluation and accreditation of over 22,000 healthcare organizations across the U.S., utilizes the rate of NTSV cesarean deliveries as a national core measure of perinatal quality (Baker, 2019). Additionally, reducing the rate of NTSV cesarean deliveries is a national public health priority (Armstrong et al., 2016), and has been an objective of Healthy People Initiative, the Society for Maternal-Fetal Medicine (SMFM), the Agency for Healthcare Research and Quality (AHRQ), and the American College of Obstetrics and Gynecologists (ACOG) due to its impact on health outcomes, quality, and costs in the U.S. As such, addressing the rates of low-risk cesarean deliveries is an "upstream" approach to an important public health issue (Kozhimannil, Thao, et al., 2016; Yamamoto, 2011).

Variation in NTSV Cesarean Delivery

Particularly troubling about the issue is the lack of clear rationales for the increases in and widespread variation of the overall and NTSV cesarean delivery rates (Panda et al., 2018). Global examinations of the utilization of cesarean sections illustrate an emerging pattern of health care inequity, in which cesarean sections are underutilized in low-income settings and overutilized in middle and high income settings (Matevosyan, 2015). Overutilization of NTSV cesareans can lead to poorer health outcomes, higher health care costs, and lower reported quality of care (Fisher & Welch, 1999; Hoxha et al., 2019; Oakes et al., 2019; Roth & Henley, 2014; Shaw et al., 2016; Wennberg, 2004). Conversely, underutilization can also lead to adverse outcomes due to those who need a cesarean but cannot access them (Hoxha et al., 2019). On the global scale, the U.S.'s reliance on obstetricians for the provision of perinatal care and presence at deliveries over other types of perinatal care providers is in part responsible for the inflated rates relative to other industrialized nations (Miller & Shriver, 2012). Further, the for-profit structure of the U.S. health care system can incentivize providers to overutilize certain procedures, such as cesarean deliveries, due to the current reimbursement structure which compensates operative deliveries at higher rates than vaginal deliveries (Hoxha, Syrogiannouli, Braha, et al., 2017; Roth & Henley, 2014). A recent study suggested that increasing physician and/or hospital profit for cesarean delivery is associated with substantial increases in cesarean utilization, particularly at the hospital level (Foo et al., 2017). In a similar study of the association between cesarean delivery utilization in low-risk pregnancies and hospital profits using national level data, the authors found that women who delivered in hospitals with the higher profits per procedure were at a 5.3 times higher odds of delivering via cesarean compared to women whom delivered in hospitals with the lower profits per procedure (Sakai-Bizmark et al., 2021).

Factors Contributing to NTSV Cesarean Delivery

The changes in the multifaceted factors which influence the utilization of cesarean sections have been driven not only by growing scientific understanding, but by the evolving social, cultural, and legal landscape in the U.S. (Mylonas & Friese, 2015). Indications of cesarean deliveries are broadly divided into two categories, clinical and non-clinical (Haberman et al., 2013; Matevosyan, 2015; Mylonas & Friese, 2015). Clinically, increases in cesarean deliveries have been, in part, attributed to changing risk profiles among nulliparous, or first time, mothers, objective measures of risk, such as HIV infection and extreme birthweight, and subjective measures of risk, such as fetal distress or arrest of dilation (Kaimal & Kuppermann, 2012; Panda et al., 2018; Reyes & Rosenberg, 2019; Roth & Henley, 2014; Weimer et al., 2019). A collaboration of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, ACOG, and the SMFM in 2012 noted that there are very few absolute indications of need for cesarean delivery and that the majority of decision making is based on subjective indications which are heavily influenced by physician and health system-related factors (Spong et al., 2012). Research indicates that personal beliefs and preferences, hospital policies and guidelines, health care practice coverage, lack of access to facilities and resources, lack of cooperation among professionals, and fear of legal consequences play a role in a provider's decision to perform a low-risk NTSV cesarean section (Barber et al., 2011; Henke et al., 2014; Panda et al., 2018; Reyes & Rosenberg, 2019). Increasingly over the last several decades, there has been a shift in obstetric practice patterns to a risk-oriented and defensive practice to deal with increasing medicolegal pressure (Abenhaim et al., 2007; Mushinski et al., 2021; Mylonas & Friese, 2015). In the U.S., rises in malpractice insurance premiums has alienated providers from specializing in obstetrics which has resulted in an inequitable distribution of providers (Mylonas & Friese, 2015). Rising costs of insurance premiums further inclines providers towards cesarean sections when subjective measures, such as fetal heart tracings, are questionable (Barber et al., 2011). Further, obstetricians may elect to perform a cesarean section if they are not well versed or confident in their abilities to perform the surgical alternatives of vaginal delivery, such as the utilization of forceps or vacuum during labor and delivery (Matevosyan, 2015).

Non-clinically, patient characteristics, such as race/ethnicity, insurance status, and provider characteristics, such as the type of provider, labor management techniques and demographics, are major drivers in the variations in cesarean delivery rates (Haberman et al., 2013; Janakiraman et al., 2011; Kaimal & Kuppermann, 2012; Roth & Henley, 2014). One of the most commonly cited and controversial reasons for increasing rates of non-medically indicated cesarean deliveries is due to maternal request, which is defined as a "planned cesarean delivery in a low-risk pregnancy on maternal request in the absence of any maternal or fetal indication" (Viswanathan et al., 2006; Yamamoto, 2011). However, maternal request does not fully account for the relative magnitude of the increases in NTSV cesarean deliveries over the last several decades and underestimates the provider's influence on decision-making (Barber et al., 2011; Bodner et al., 2011; McCourt et al., 2007; Mylonas & Friese, 2015; Weimer et al., 2019). Further, there is debate as to the actual prevalence of cesarean delivery by maternal request as it is not clearly indicated or recorded on health records or surveys (Yamamoto, 2011).

The factors which influence a woman's choice to request a cesarean delivery, especially in low-risk pregnancies, are complex and difficult to articulate (Jenabi et al., 2020). These choices are further complicated by social and cultural differences in the perception of the role of the prenatal care provider and the perceptions of need for medical or technological intervention during labor and delivery (Miller & Shriver, 2012; Reyes & Rosenberg, 2019). Commonly noted motives for maternal request for a non-medically indicated cesarean delivery include but are not limited to fear of childbirth, prevention of maternal morbidities such as pelvic organ prolapse, urinary and/or anal incontinence, timing of birth, prior birth experiences, anxiety, and avoidance of prolonged labor (Betrán et al., 2018; Jenabi et al., 2020).

Demographic characteristics associated with increases in maternal request for non-medically indicated cesarean delivery include parity, educational attainment, maternal obesity, household income, lower levels of religiosity, and advanced maternal age (Jenabi et al., 2020). Culture also plays a major role in the perception of risk, with research suggesting that women's choices during pregnancy are dependent on which options are less "risky" based on their cultural belief system (Miller & Shriver, 2012). Cultural influences, generally seen as subjective, are commonly overlooked for the more objective measures of morbidity and mortality within the prenatal health care system in the U.S. (Miller & Shriver, 2012).

In studies of childbirth fear conducted in Europe, where childbirth fear is more commonly assessed and treated during pregnancy, nulliparous women who reported and were diagnosed with fear of childbirth were 3.3 times more likely to deliver via cesarean without medical indications (Stoll et al., 2018). In a survey of Canadian women during the perinatal period utilizing the Childbirth Fear Questionnaire, results indicated that women who reported seeing an obstetrician as their primary prenatal care provider reported higher levels of fear of childbirth compared with women who reported having a midwife as their primary prenatal care provider (Stoll et al., 2018). Interestingly, women whose primary prenatal care provider was an obstetrician were significantly less fearful of cesarean deliveries compared to women who primarily saw a midwife during pregnancy (Stoll et al., 2018). As such, evidence illustrates that women who receive care from obstetricians have higher rates of low-risk cesarean deliveries, compared to women who receive care from midwives (Carlson et al., 2020; Damiano et al., 2020). This, in part, is attributed to the fact that women who see obstetricians as their primary prenatal care provider are more likely to have higher-risk pregnancies compared to those who see midwives, who are more likely to treat low-risk women (Bailit, 2012; Stoll et al., 2018).

In a study of mode of delivery preference among college-aged women in the U.S., it was noted that women who reported preferring a cesarean delivery were approximately twice as likely to report extreme fear of childbirth compared to women who reported a preference for a vaginal delivery (Reyes & Rosenberg, 2019). These women were also four times more likely to report that their fear of childbirth directly influenced their preference (Reyes & Rosenberg, 2019). Additional influences on a women's preference for a cesarean delivery over a vaginal delivery include perception of lower risk and greater efficiency than vaginal delivery, fear of impact of delivery on their body, and the ability to schedule delivery (Reyes & Rosenberg, 2019). A proportion of the women who reported preferring a planned cesarean delivery viewed it as a preemptive measure to prevent an emergency cesarean delivery and its potential complications (Reyes & Rosenberg, 2019). A survey of obstetricians in the U.S. noted that approximately 31% of female obstetricians reported a preference for a cesarean delivery in their first low-risk pregnancy, the vast majority (80%) reporting fear of pelvic region damage as their primary influence in this decision (Bodner et al., 2011). Convenience can play a further role, with research suggesting that mothers and physicians may plan cesareans to alleviate fears and potential risks (Jenabi et al., 2020). Interestingly, while evidence suggests a personal preference for a low-risk cesarean delivery, a systematic analysis of the current body of literature noted that compared to their male counterparts, female obstetricians were less likely to report a preference to perform a cesarean delivery without medical need (Hoxha et al., 2020).

Physician influence has a major impact on decision making during the perinatal period due to the competition between knowledge, societal pressures, and varied other considerations (Jou et al., 2015). A nationally representative survey of women of reproductive age (18-45 years), found that 13.3% of women reported feeling pressured by their provider to have a cesarean delivery, and of the women who delivered by cesarean section over half were done without medical indication (Jou et al., 2015). When adjusting for socioeconomic characteristics, perceived pressure from physicians were significantly associated with increased odds of cesarean delivery, over five times higher odds in the overall cesarean deliveries and over six times higher odds in cesarean deliveries without medical indication (Jou et al., 2015).

Another non-clinical factor which has been shown to be associated with low-risk NTSV cesarean delivery rates is the time of day (Son et al., 2020). Time of day can be utilized as a proxy measure for health-system related characteristics, including staffing, structural capacity, and provider-related factors (Son et al., 2020). Evidence suggests that providers may either delay use of labor inducing drugs overnight or utilizing cesarean sections early in labor to fit within specific daytime work hours (Bailit, 2012; Brown, 1996; Burns et al., 1995; Roth & Henley, 2014). Current observational research has indicated that the frequency of low-risk cesarean deliveries is higher during the day and declines into the evening (Son et al., 2020). Conversely, a retrospective multicenter study of the Consortium on Safe Labor (CSL) data by Haberman and colleagues noted that among nulliparous cesarean deliveries, the evening hours (after 8 p.m.) were associated with the highest risk of cesarean delivery (Haberman et al., 2013). Haberman and colleagues also found that the cesarean deliveries among nulliparous were least likely on Saturday and Sunday (Haberman et al., 2013). The evolving nature of staffing and scheduling of obstetricians from 24-hour availability to rotating on-call scheduling over the last several decades also has implications on the rate of cesarean deliveries (Abenhaim et al., 2007). In a hospital-based cohort study of births in Montreal, Canada, Abenhaim and others noted a statistically significant increase in the odds of cesarean delivery among women who were attended by an on-call obstetrician compared to their regular provider, due in major part to "non-reassuring" fetal heart tracings (Abenhaim et al., 2007). Further, women who received a cesarean delivery by an on-call physician due to fetal heart tracings were more likely to have a cesarean delivery in the first stage of labor compared to women who were attended by their regular obstetrician (Abenhaim et al., 2007). This variation, in part, could be due to the lack of familiarity with the patient, and fear of potential litigation (Abenhaim et al., 2007).

Disparities in access to health care, and more specifically different perinatal health care providers, can limit women's autonomy in planning their births further adding to the pattern of health inequity associated with cesarean births (Miller & Shriver, 2012). Moreover, stereotyping and provider bias plays a major role in health inequities in the U.S. (Delafield et al., 2021). Research has noted that higher hospital volume has been associated with improved clinical outcomes, though research regarding the relationship hospital and physician volume and maternal outcomes has been conflicting and limited in generalizability (Kozhimannil, Thao, et al., 2016). In 2016, Kozhimannil and colleagues conducted a national level study of the variation in maternal health outcomes based on hospital teaching status and hospital volume (Kozhimannil, Thao, et al., 2016). They noted that the association between hospital birth volume and maternal outcomes was generally dependent on geography and hospital teaching status. Specifically, that in non-teaching hospitals, rural or urban, poor maternal health outcomes were lowest in high volume hospitals, whereas in urban teaching hospitals higher volume was associated with increased risk of maternal morbidity (Kozhimannil, Thao, et al., 2016). Conversely in a study by Clapp and colleagues, rural hospitals had lower odds of cesarean delivery compared to higher volume urban hospitals, both teaching and non-teaching (Clapp et al., 2018). This is in part attributable to patient characteristics of lower volume hospitals, as Clapp and others noted that low volume hospitals in their study were more likely to treat publicly insured patients with fewer comorbidities (Clapp et al., 2018). Similarly, Janakiraman and colleagues noted in their national level study of health system volume and childbirth outcomes, that hospitals with the highest annual birth volume (>1700 births per year) were more likely to treat patients with higher levels of obstetric risk (Janakiraman et al., 2011). Trends in maternal characteristics and outcomes are also noted at the provider level; low-volume providers tend to treat patients with higher medical risk than high-volume providers (Janakiraman et al., 2011). In a study of deliveries in hospitals with obstetric services versus those without obstetric services, there was substantial variation in patient characteristics (Handley et al., 2021). Patients in non-obstetric hospitals were more likely to have public insurance, whereas those who delivered in a hospital with obstetric services were more likely to be of advanced maternal age and have comorbidities (Handley et al., 2021).

Outcomes, Quality, and Costs

The rate of NTSV cesarean deliveries has implications on health care outcomes, quality, and cost and further highlights existing disparities in the maternal health in the U.S. Low-risk cesarean delivery has been shown to be associated with immediate and future adverse outcomes in women (Sandall et al., 2018). Women who have a cesarean delivery are more liking to experience a severe acute maternal morbidity event such as hemorrhage, uterine rupture, cardiac arrest, need for blood transfusion, and major puerperal infections compared to women who deliver vaginally (Curtin et al., 2015; Henke et al., 2014; Kozhimannil, Law, et al., 2013; Matevosyan, 2015; Mylonas & Friese, 2015; Sandall et al., 2018; Skeith et al., 2018). Women who deliver via cesarean also generally need longer recovery periods and are more likely to be admitted to the intensive care unit compared to women who deliver vaginally (Curtin et al., 2015; Jenabi et al., 2020; Kozhimannil, Law, et al., 2013; Sandall et al., 2018). Moreover, women who deliver via cesarean section have a higher likelihood of being readmitted to the hospital within 6 weeks following delivery (Belfort et al., 2010). In the postpartum period, women who have a cesarean delivery are at an increased risk for thromboembolic complications (Skeith et al., 2018). Further women who had a prior cesarean, are more likely to experience complications in subsequent labors including placental disorders, uterine adhesions, uterine rupture, and more (Clark & Silver, 2011; Henke et al., 2014; Mylonas & Friese, 2015; Osterman & Martin, 2014; Silver, 2010; Spong et al., 2012). Additionally, women who have a cesarean delivery may have more difficulty initiating and maintaining breastfeeding after hospital discharge, though the evidence of this association is mixed (Mylonas & Friese, 2015). Geographically, low-resource communities are at higher risk for cesarean-related maternal mortality compared to high-resource communities (Sandall et al., 2018).

In addition to the increased risk of maternal morbidity and mortality, low-risk cesarean deliveries also have major implications on neonatal morbidity and mortality as infants born by cesarean are subjected to different medicinal, bacterial, hormonal, and physical exposures relative to infants born by vaginal delivery (Mylonas & Friese, 2015; Sandall et al., 2018). An emerging body of evidence suggests that medical intervention during the intrapartum period can affect physiological development (Sandall et al., 2018). Inadequate transfer of the maternal microbiome, increased exposure of infants to prophylactic antibiotics, decreased exposure maternal stress hormones and labor forces, and exposure to synthetic medications in cesarean delivery relative to vaginal delivery are the current hypotheses utilized to explain differences in health outcomes between cesarean deliveries relative to vaginal deliveries (Sandall et al., 2018). Short-term neonatal health outcomes associated with cesarean delivery include respiratory distress, asthma, altered immune development, and allergies (Matevosyan, 2015; Mylonas & Friese, 2015; Sandall et al., 2018). Additionally, infants born via non-medically indicated cesarean section are more likely to be transferred to the neonatal intensive care unit (NICU) compared to infants born via vaginal delivery (Matevosyan, 2015). Cesarean delivery has also been associated with increased risk of childhood obesity (Pei et al., 2014; Sandall et al., 2018; Sitarik et al., 2020).

The global cost of non-medically indicated cesarean deliveries is approximately $2 billion dollars (Matevosyan, 2015). In the U.S. the cost of childbirth is substantially greater relative to other developed nations, due in part to significant increases in cesarean deliveries (Shaw et al., 2016). Annually, the costs of maternity-related hospitalizations in the U.S. is greater than $27 billion (Kozhimannil, Attanasio, et al., 2014). Further, pregnancy, childbirth, and clinical care for newborn infants are the most expensive conditions billed to insurance, both private and public (Jolles, 2017; Kozhimannil, Attanasio, et al., 2014). According to the AHRQ, the average cost of a cesarean delivery ranges from $4,700-6,500 depending on the presence of complications (Moore et al., 2006). Estimates in the differences in cost for cesarean deliveries, on average, range from $3,000-5,000 more than a vaginal delivery depending on insurance coverage and geography (Johnson et al., 2020; Kozhimannil, Hardeman, et al., 2013). Factors contributing to the increase costs of cesarean delivery include increased drug use during delivery, nursing services, longer hospital stays, and facility fees (DeJoy et al., 2020; Henke et al., 2014; Jenabi et al., 2020; Jolles, 2017). The differential in costs associated with cesarean deliveries, compared with vaginal deliveries, is a determinant of utilization, but the extent to which it explains overall variations is not well understood (Weimer et al., 2019). Cesarean deliveries are a major economic burden on U.S. taxpayers as Medicaid covers approximately half of all births in the U.S., which was approximately $3 billion dollars in 2009 (Henke et al., 2014; Kozhimannil, Law, et al., 2013). Evidence suggests that women who give birth via cesarean section reported less immediate and long-term satisfaction with their birth experience relative to women who delivered vaginally (Sandall et al., 2018).

Rising cesarean delivery rates are a major public health issue leading to poorer health outcomes, poorer quality of care, and higher healthcare expenditures. The purpose of this dissertation is two-fold. First, to illustrate the current variation of NTSV and elective cesarean deliveries in the U.S. Second, to determine if the trends in the prevalence of NTSV and elective cesarean deliveries varies between the U.S. and Appalachia, a culturally distinct sub-region of the U.S. which has been known to be disproportionately burdened by poor health and lack of access to healthcare (Marshall et al., 2017; Meit et al., 2017a; G. K. Singh et al., 2017; G. K. Singh & Siahpush, 2014; *Socioeconomic Overview of the Appalachian Region - Appalachian Regional Commission*, n.d.; *The Appalachian Region - Appalachian Regional Commission*, n.d.).

Assessing and addressing the rates of NTSV and elective cesarean deliveries is an "upstream" approach to reducing poor health outcomes and high health care expenditures, while also increasing patient satisfaction (Yamamoto, 2011).

Epidemiologic Trends

Globally, cesarean sections have been increasing in developed and developing nations with over six million non-medically indicated cesarean deliveries occurring annually, making it one of the most commonly performed surgical procedures across the globe (Boerma et al., 2018; Mylonas & Friese, 2015; Sandall et al., 2018). Evidence suggests that over the last three decades, there has been an average increase in cesarean deliveries of approximately 4% per year (Betrán et al., 2016). These substantial increases have been shown to be driven by increases in low-risk cesarean deliveries, cesarean deliveries by maternal request, and decreases in length of trial of labor following a previous cesarean delivery (Rivo et al., 2018; Spong et al., 2012). Moreover, research indicates that there is an unequal distribution of cesarean sections across the world, with the substantial increases attributed to overutilization of cesarean deliveries in middle- and high-income countries (Boerma et al., 2018; Matevosyan, 2015). The U.S. has the one highest rates of cesarean deliveries relative to other industrialized nations, only surpassed by countries in Latin America (Boerma et al., 2018; Boyle & Reddy, 2012; Henke et al., 2014; Hoxha et al., 2019; Hoxha, Syrogiannouli, Braha, et al., 2017). Similar trends have been noted among low-risk NTSV cesareans on the global level over the last several decades (Boyle & Reddy, 2012). Evidence suggests the widespread variation in cesarean deliveries, on the global level, is predominantly attributable to institution characteristics, specifically institution ownership (private vs. public), having greater than 50 maternity beds, and if there is an existing incentive structure for the performance of cesarean deliveries (Boyle & Reddy, 2012; Weimer et al., 2019). A systematic analysis of the association between hospital ownership and cesarean delivery rates found an average 1.4 times increase in the odds of having a cesarean delivery in private for-profit hospitals compared to non-profit institutions (Hoxha, Syrogiannouli, Luta, et al., 2017). Similarly, variation in low-risk NTSV cesareans have also been associated institutional and health care related characteristics, including with labor induction rates and early labor admissions (Boyle & Reddy, 2012; Coonrod et al., 2008; Rivo et al., 2018). However, the influence of labor induction on risk of cesarean delivery is mixed (Caughey et al., 2009; Ehrenthal et al., 2010; Kjerulff et al., 2017; Middleton et al., 2020; Mishanina et al., 2014; Vahratian et al., 2005; Wennerholm et al., 2009; Wood et al., 2014).

In the U.S., cesarean sections are the most commonly performed major surgery (Boyle & Reddy, 2012; Haberman et al., 2013; Weimer et al., 2019). The rate of cesarean deliveries has increased dramatically in the U.S. from 5.5% of births in 1970 to 31.7% of births in 2019 (Carlson et al., 2020; Coleman et al., 2009; Henke et al., 2014; Martin et al., 2021; Placek & Taffel, 1980). Increases in cesarean deliveries were seen across all demographic groups (races/ethnicities, ages, gestational ages) (Boyle & Reddy, 2012). One study noted at least a 50% increase in cesarean delivery rate across the sub-groups from 1996 to 2009 (Boyle & Reddy, 2012). Similarly, the rate of low-risk NTSV cesarean deliveries increased 45% between 1997 and 2017 (DeJoy et al., 2020).

Further, substantial variation in cesarean rates persists across the U.S. at the regional, state, and health system levels (Baicker et al., 2006; Boyle & Reddy, 2012; Coonrod et al., 2008; DeJoy et al., 2020; Hoxha et al., 2019; Hoxha, Syrogiannouli, Braha, et al., 2017; Kozhimannil, Law, et al., 2013; Vanderlaan et al., 2020). This variation is even greater among low-risk pregnancies. A study in 2013 by Kozhimannil and colleagues found a fifteenfold difference in low-risk cesarean deliveries despite similar maternal health profiles (Kozhimannil, Law, et al., 2013). Geographically, rural regions of the U.S. are disproportionately burdened by lack of access to obstetric providers and facilities (Vanderlaan et al., 2020). Further, the majority of hospitals and healthcare systems which ended obstetric services are predominantly in rural settings (Vanderlaan et al., 2020). A study of the geospatial distribution of cesarean deliveries in the state of Georgia found that counties with high rates of cesarean deliveries also has higher proportions of births to minority women, lower proportions of providers, and higher proportions of births covered by Medicaid (Vanderlaan et al., 2020). Approximately half of the high-rate clusters were identified in rural counties, however, the authors note that since a substantial portion of the high-rate clusters are not rural counties that variations in cesarean deliveries is only in part attributable to lack of resources (Vanderlaan et al., 2020). Evidence also suggests that patients living in more affluent communities had lower odds of cesarean delivery compared to women who lived in lower income areas (Clapp et al., 2018).

Demographic Trends

Maternal characteristics associated with higher risk of low-risk cesarean deliveries include maternal age, race/ethnicity, socioeconomic status, obesity, educational attainment, insurance coverage, and timing of prenatal care (Coonrod et al., 2008; Haberman et al., 2013; Poobalan et al., 2009). At the population level, women of advancing maternal age and women of increasing body mass index (BMI) are at a higher risk of having a low-risk NTSV cesarean delivery (Andrikopoulou et al., 2021; Boyle & Reddy, 2012; Coonrod et al., 2008; Damiano et al., 2020; Henke et al., 2014). Women of racial/ethnic minorities, particularly non-Hispanic black women, are more likely to have a cesarean birth relative to non-Hispanic white women (Andrikopoulou et al., 2021; Coonrod et al., 2008; Kozhimannil, Hardeman, et al., 2013; Kozhimannil, Macheras, et al., 2014). This is in part due to generally higher prevalence of pregnancy-related risk factors among non-Hispanic black women (Roth & Henley, 2014). Other studies note that Asian and Hispanic women have lower rates of cesarean deliveries relative to non-Hispanic white women (Kozhimannil, Hardeman, et al., 2013). Research suggests that low-risk cesareans are more common among women of higher socioeconomic status (Gould et al., 1989; Roth & Henley, 2014). Similarly, evidence suggests that higher levels of educational attainment are associated with higher likelihood of cesarean delivery (Roth & Henley, 2014). Lack of comprehensive prenatal care has been shown to be associated with increased risk of cesarean delivery (N. Singh et al., 2020).

As aforementioned, insurance status has also been identified as a factor which influences the variation in cesarean delivery rates, however the current body of scholarly literature on the relationship between insurance status and rate of cesarean deliveries is mixed (Hoxha et al., 2019). In some studies, women who lack insurance coverage have been shown to be less likely to have a cesarean delivery compared to women with private insurance (Hoxha et al., 2019). Similarly, uninsured women are at a lower odds of having a cesarean delivery compared to publicly insured women, however the magnitude of the difference is much lower between uninsured and publicly insured women compared to uninsured and privately insured women (Hoxha et al., 2019). Further, additional studies note women with private insurance had a higher likelihood of delivering via cesarean relative to publicly insured women (Andrikopoulou et al., 2021; Henke et al., 2014; Hoxha, Syrogiannouli, Braha, et al., 2017; Kozhimannil, Hung, et al., 2014a). Conversely, other observational studies at the institutional level have noted that among nulliparous women with public insurance were at an increased risk of delivering via cesarean relative to women who were privately insured, highlighting the complexity between payment source and cesarean delivery (Haberman et al., 2013).

Institutional characteristics which have been associated with variation in cesarean deliveries include location, number of acute care beds per capita, as well as the number of obstetricians and gynecologists (OB/GYN) per capita, provider practice culture, patient volume, and policies surrounding early labor hospital admission (Henke et al., 2014; Vanderlaan et al., 2020). The staffing capabilities and models are also an important factor related to variation in cesarean deliveries (Bailit, 2012). In a study of low-risk cesarean deliveries in Arizona, institutional factors associated with lower risk of cesarean delivery included hospitals which staffed in house obstetricians, maternal fetal health specialists, obstetric residents, and anesthetists, as well as those which had tertiary nurseries (Coonrod et al., 2008). In a study of U.S. hospitals, Clapp and colleagues did not find a statistically significant association between hospital ownership and cesarean delivery rates (Clapp et al., 2018). However, a systematic review of the literature conducted by Hoxha and others found that hospital ownership was significantly associated increased risk of cesarean delivery (Hoxha, Syrogiannouli, Luta, et al., 2017).

Provider demographics also play a key role in the variation of cesarean delivery rates. Research suggests that differences in provider practice patterns are a major driver of overuse of low-risk cesarean deliveries in the U.S. (Kozhimannil, Law, et al., 2013). A systematic review of the association between physician gender and cesarean delivery rate noted that the cesarean delivery rate was lower among female physicians compared to male physicians (Hoxha et al., 2020). Female obstetricians are less likely to perform a cesarean delivery on maternal request compared to male obstetricians (Hoxha et al., 2020). While provider and institutional level factors are important to consider, recent research on the geographic variation in cesarean deliveries in the U.S. by payer type indicated that patient level factors were more predictive of cesarean delivery than institution or population level characteristics (Henke et al., 2014).

Potential Return on Investment

There is a substantial potential return on investment in addressing the low-risk NTSV cesarean delivery rate as it influences all aspects of the Triple Aim, outcomes, quality, and cost (Berwick et al., 2008). In addition to the significant expense cesarean deliveries represent immediately, this procedure has further costs when considering treating the short- and long-term health consequences of non-medically indicated cesarean deliveries as discussed above. As such addressing the low-risk cesarean delivery rate is an “upstream” approach to improving maternal and child health outcomes. Investing in lowering low-risk NTSV cesarean deliveries can help reduce the incidents of both maternal and child morbidity which will help reduce the future healthcare costs of each dyad. An economic evaluation of deliveries in a Massachusetts health system, noted that the average difference in costs related to primary cesarean section and newborn care was approximately $6,000 greater compared to women who delivered vaginally (DeJoy et al., 2020). This hospital joined the American College of Nurse-Midwives' Healthy Birth Initiative the Reducing Primary Cesareans Learning Collaborative which encourages health systems to reduce the incidence of low-risk NTSV through the utilization of evidence-based care bundles and midwife-led interprofessional labor and delivery teams (DeJoy et al., 2020). Post-implementation, the hospital reported the prevention of 69 primary cesarean deliveries which led to an estimated savings of over $410,000 in 2016 (DeJoy et al., 2020). The authors project an additional savings of approximately $280,000 for the prevention of subsequent cesarean deliveries (DeJoy et al., 2020). In addition to the immediate post-partum savings of fewer low-risk cesarean deliveries, health care organizations could see short-term reduction of costs in other areas such as lower rates of ICU and NICU admissions, and lower rates of rehospitalization within 6 weeks post-partum (Belfort et al., 2010; Curtin et al., 2015; Jenabi et al., 2020; Kozhimannil, Law, et al., 2013; Sandall et al., 2018). Long-term investing in the reduction of low-risk cesarean deliveries can lower the costs of future labor and deliveries by reducing the rates of complications such as placental disorders, uterine adhesion, and uterine rupture (Curtin et al., 2015; Sandall et al., 2018). Further, reducing the rate of low-risk cesarean deliveries can potentially save health care organizations, systems, and U.S. taxpayers by reducing the risk of asthma, respiratory distress syndrome, and childhood obesity associated with cesarean deliveries (Matevosyan, 2015; Mylonas & Friese, 2015; Pei et al., 2014; Sandall et al., 2018; Sitarik et al., 2020). As evidenced, investing in the reduction of low-risk non-medically cesarean deliveries has substantial return on investment in health care outcomes, for mothers and infants, as well as health care expenditures.

Extent to Which the Problem is Amenable to Change

The extent to which a public health issue, such as the rising rate of low-risk cesarean deliveries, is amenable to change can be, in part, reflected by the availability of modifiable risk factors associated with the issue. As aforementioned, the decision to perform a low-risk or primary cesarean delivery is based predominantly on a provider's subjective responses to ongoing labor management as such these factors in the decision-making process are particularly amenable to modification (Spong et al., 2012). Additionally, patient and provider perception of risks and attitudes towards low-risk cesarean deliveries are a modifiable risk factor (Spong et al., 2012).

Additionally, the extent to which a public health issue is amenable to change can also be reflected by the number of interventions which have been shown to improve the issue. As aforementioned, the substantial increases in the rates of low-risk NTSV cesarean deliveries has garnered attention from many governmental agencies, public health agencies, and the medical community as an issue of importance due to the lack of consistent guidelines for medically indicated need for the procedure and the short- and long-term health implications the procedure has on both mothers and infants (Betrán et al., 2016; "Obstetric Care Consensus No. 1: Safe Prevention of the Primary Cesarean Delivery," 2014). The growing body of evidence which suggests that the risks and repercussions of low-risk NTSV cesarean deliveries outweigh the benefits which has led to the emergence of a variety of policies and non-clinical interventions aimed to reducing the rate of low-risk cesarean deliveries.

Policy

Policies, at the national and state level, focused on maternity care have attempted to facilitate the reduction of low-risk and primary cesarean deliveries. At the federal level, in 2010, the Partnering to Improve Maternity Care Quality Act was introduced to Congress with the intention of amending Title XIX of the Social Security Act, which encompasses Medicaid and CHIP, to improve the quality and outcomes of perinatal care by establishing a core set of maternity care quality measures, identify and support the development of evidence-based perinatal health care, and evaluate alternative reimbursement and payment structures (Kozhimannil, Law, et al., 2013).

At the organizational level, to address the rising rates of cesarean deliveries in 2014 the American College of Obstetrics and Gynecologists (ACOG) and the Society for Maternal-Fetal Medicine (SMFM) published the obstetric care consensus *Safe prevention of the primary cesarean delivery*, a new guideline which updated the definitions of failed induction and arrest of labor and provided new strategies for their management in an effort to reduce low-risk NTSV cesarean deliveries ("Obstetric Care Consensus No. 1: Safe Prevention of the Primary Cesarean Delivery," 2014; Thuillier et al., 2018). This consensus was based on findings using the Consortium of Safe Labor data which indicated that historic estimates of labor progression were much faster than what was observed contemporarily (Spong et al., 2012; J. Zhang et al., 2010).

Research also indicates that a major arrest of labor in the second stage, defined as the period of time from full dilation of the cervix to delivery of the infant, is a primary cause for low-risk NTSV cesarean deliveries in the U.S. (Barber et al., 2011; Boyle et al., 2013; Zipori et al., 2019). Results on the primary cesarean delivery rates pre- and post-implementation of the ACOG-SMFM guidelines have been mixed on the national and international levels. In a study of the implementation of these new guidelines in a healthcare system in France, Thuillier and colleagues found that among low-risk NTSV women who delivered in their system post-implementation that there was a significant decrease in the cesarean deliveries (OR= 0.71) (Thuillier et al., 2018). The study also saw significant reductions across the most common indications for cesarean deliveries among low-risk mothers including arrest of labor, failed induction, and non-reassuring fetal heart rate (Thuillier et al., 2018). Concurrently, with the reduction of low-risk cesarean deliveries the authors correspondingly found that the average length of the trial of labor was greater post-implementation of the new guidelines (Thuillier et al., 2018). Conversely, in a study of the impact of the ACOG-SMFM guidelines in a university-affiliated medical center in Israel, Kadour-Peero and colleagues found in their unadjusted analyses that there was a significant increase in primary cesarean deliveries among low-risk women, defined as a singleton pregnancy at term with the infant in vertex position, following the implementation of the new ACOG-SMFM guidelines from 4.0% to 5.9% (Kadour-Peero et al., 2021). Among nulliparous low-risk women, after adjustment for confounders, the rate of cesarean deliveries utilized during the second stage of labor was higher after the implementation of the new ACOG-SMFM guidelines (aOR=1.418), especially among nulliparous women who received an epidural (aOR=1.574) (Kadour-Peero et al., 2021). Further whereas Thuillier and colleagues and Kadour-Peero and others found significant differences in cesarean delivery rates pre- and post-implementation of ACOG-SMFM guidelines, Jalloul and colleagues did not find significant differences in the cesarean delivery rates in a retrospective cohort study of a Texas county hospital prior to and after implementation of the new labor management guidelines (Jalloul et al., 2021). As the studies of the impact of the ACOG-SMFM guidelines on cesarean delivery rates are predominantly retrospective studies in single healthcare facilities or systems, further research, particularly randomized control trials, are needed to assess the impact of the implementation of the ACOG-SMFM guidelines more completely on primary cesarean delivery rates.

Adherence is an important consideration as to the effectiveness of new policy guidelines. In a retrospective study of Children's Memorial Hermann Hospital-Texas Medical Center in Houston, Texas, found that of cesarean sections in low-risk women that were performed due to arrest of labor 73% were non-adherent to the ACOG-SMFM guidelines. Further, non-adherence was much more common in the beginning, or latent, phase of labor relative to active or second stage labor (Alrais et al., 2019). Providers who adhered to ACOG-SMFM guidelines reported longer labor arrest duration and subsequently longer trials of labor compared to the non-adherent providers (Alrais et al., 2019). Private physicians, defined as those not employed by the medical center, were less likely to adhere to guidelines compared to academic providers (Alrais et al., 2019). Further, in a comparison of adherence based on time of delivery Alrais and colleagues found that providers were more likely to adhere to guidelines during weeknight shifts (5:30 pm-6:00 am), which is consistent with current observational evidence that providers are more likely to perform cesarean deliveries within daytime "work" hours (Alrais et al., 2019; Son et al., 2020). Escobar and colleagues conducted a retrospective review of cesarean deliveries that took place between March 2014 and May 2016 in an urban academic medical center to 1) determine the rate of adherence to the ACOG-SMFM guidelines, 2) evaluate differences in neonatal and maternal health outcomes in deliveries that were guideline compliant versus those that were not, and 3) determine the relationship between guideline adherence and provider cesarean delivery rates (Escobar et al., 2020). The authors found that 79% of all cesarean deliveries performed within the study period were non-adherent to the ACOG-SMFM guidelines (Escobar et al., 2020). There was no evidence that there was an increased risk for poor neonatal or obstetric outcomes in the adherent deliveries compared to the non-adherent deliveries (Escobar et al., 2020). The authors also note that adherence to the guidelines was inversely associated with provider cesarean delivery rates, in that adherence was associated with lower cesarean delivery rates (Escobar et al., 2020).

At the state level, legislation, strategic partnerships, and quality improvement programs associated with state Medicaid programs have been shown to influence rates of low-risk cesarean deliveries in the U.S. (Kozhimannil, Law, et al., 2013). In 2012, Massachusetts' state legislature addressed the financial structures which incentivized the utilization of cesarean deliveries by passing the Improving the Quality of Health Care and Reducing Costs through Increased Transparency, Efficiency, and Innovation Act which encourages the coordination of care through bundled payments across providers and healthcare settings (Kozhimannil, Law, et al., 2013). Reductions in the rates of non-medically indicated low-risk cesarean deliveries have been noted in states, such as Ohio, which established strategic partnerships and perinatal quality care collaboratives (Kozhimannil, Law, et al., 2013).

Practice

Interventions aimed at reducing non-medically indicated cesarean deliveries can be broadly grouped into interventions targeting mothers and families and interventions targeting health care providers and organizations (Chen et al., 2018). Interventions targeting mothers and families do so in order to address the socio-demographic and patient level characteristics which may predispose a woman to higher risk of a NTSV cesarean delivery (Chen et al., 2018). These interventions are most commonly educational programs which can include but are not limited to pyscho-educational and relaxation programs and childbirth training (Chen et al., 2018).

Organization level interventions to reduce low-risk NTSV cesarean deliveries are generally focused on models of care, organizational policy, insurance reform and reimbursement, and organizational culture reform (Chen et al., 2018). Evidence suggests that models of care, such as the collaborative midwifery-laborist model in which an obstetrician provides 24-hour in-facility labor and delivery coverage without competing clinical or administrative duties, have to been shown to reduce the rate of cesarean deliveries (Chen et al., 2018; Nijagal et al., 2015). Similarly, a study on doula care, or birth companionship, conducted in the U.S. have shown promise in reducing low-risk NTSV cesarean deliveries, particularly among Medicaid beneficiaries (Kozhimannil, Attanasio, et al., 2014; Kozhimannil, Hardeman, et al., 2013, 2016). Further, randomized control trials of doula supported labor and deliveries indicated that continuous labor support was also associated with higher rates of spontaneous vaginal delivery, higher patient satisfaction, and higher infant Apgar scores (Hodnett et al., 2013; Kozhimannil, Attanasio, et al., 2014; Kozhimannil, Hardeman, et al., 2013). Kozhimannil and colleagues conducted a retrospective analysis of the relationship between receiving doula care, wanting but not receiving doula care, and cesarean delivery in a nationally representative sample of U.S. mothers, they found that younger (24 years or younger) and first time mothers are more likely to report utilizing and wanting to utilize doula care compared to mothers 35 years and older (Kozhimannil, Attanasio, et al., 2014). Of note, while having doula support did not vary significantly by race/ethnicity the desire for doula care was significantly higher among women of color compared to non-Hispanic white women (Kozhimannil, Attanasio, et al., 2014). Similarly, while there was not significant differences in the rates of women reporting utilizing doula care by payment source the desire to utilize doula services were higher among women with no insurance or public insurance compared to women who were privately insured (Kozhimannil, Attanasio, et al., 2014). After adjusting for sociodemographic and pregnancy-related characteristics, women who utilized of doula services had an 89% lower odds of having a non-medically indicated cesarean delivery than women who desired doula services but did not receive it and an 80% lower odds of having a non-medically indicated cesarean delivery compared to women who did not have or express desire for doula support (Kozhimannil, Attanasio, et al., 2014). These services were also found to be a cost effective approach to decreasing low-risk cesarean delivery rates (Kozhimannil, Attanasio, et al., 2014). It should be noted that there are disparities in access to doula services particularly for women of color and women of lower socioeconomic status due in part to the fact such services are rarely covered by health insurance programs (Kozhimannil, Attanasio, et al., 2014). Additionally, there are disparities in awareness of doula services in the U.S. In 2012, a nationally representative survey of women who gave birth in the U.S. found that 40% of women reported not being aware of what a doula is (Kozhimannil, Attanasio, et al., 2014). Further, there is a lack of diversity among the doula workforce with the majority of certified doulas being well-educated non-Hispanic white upper-middle class women (Kozhimannil, Attanasio, et al., 2014; Kozhimannil, Hardeman, et al., 2013). The improved perinatal care outcomes associated with the presence of doula services has led to several states, specifically Oregon and Minnesota to reassess and restructure their state Medicaid programs to reimburse for such programs in 2014, however these services are yet to be widely accepted and utilized across the United States (Kozhimannil, Attanasio, et al., 2014).

Research suggests that multi-component intervention strategies are a potentially more effective approach to address the rising cesarean delivery rates relative to single component interventions (Chaillet et al., 2015; Chaillet & Dumont, 2007). One such strategy that has been studied includes professional onsite training, as well as audits and feedbacks (Chaillet et al., 2015). In 2015, Chaillet and colleagues conducted a randomized control trial of an audit and feedback intervention and found a small significant decrease in the overall cesarean delivery rate in the intervention group, which consisted of provider training in evidence-based labor and delivery management techniques, clinical audits, and provision of feedback, post-intervention compared to the control group. Further, a 20% lower odds of low-risk cesarean delivery among the intervention group compared to the control group (Chaillet et al., 2015). Low-risk in this study refers to singleton pregnancies in cephalic or vertex position, with no prior cesarean births and no pathologic conditions to mothers between the ages of 18-39 years with a BMI between 17-29 who did not utilize assisted reproductive technology (Chaillet et al., 2015). The authors note that the primary drivers of these reductions was the impact of the intervention on cesarean deliveries after prolonged labor and non-medically indicated repeat cesarean deliveries (Chaillet et al., 2015). Another multi-component intervention aimed at addressing low-risk cesarean deliveries was assessed by Bell and others in a health system in North Carolina (Bell et al., 2017). This multi-component intervention was a quality improvement project which paired the Council on Patient Safety in Women's Health Care *Patient Safety Bundle on the Safe Reduction of Primary Cesarean Births* and the 2014 guidelines from ACOG and SMFM obstetric care consensus to educate providers on contemporary labor management and labor support techniques as well as develop new protocols for admission, induction of labor, and the provision of labor support (Bell et al., 2017). Analysis of this intervention noted that there was a significant decrease in low-risk NTSV cesarean deliveries, 27.9% to 19.7%, following the implementation of the intervention (Bell et al., 2017). Further there was increased provider compliance, increased utilization of maternal position changes during labor, and increased use of labor support tools (Bell et al., 2017).

Another approach developed to address the growing cesarean delivery rate is a multicomponent intervention strategy. One such program, which included updated hospital policies, provider training, and targeted health education for pregnant, was field tested in Shanghai, China using a cluster-randomized control trial from 2015-2017 (L. Zhang et al., 2020). In their study, Zhang and colleagues found that the multi-component intervention was not found to significantly reduce the cesarean delivery among the intervention group compared to the control group during the study period (L. Zhang et al., 2020).

A systematic review of interventions aimed at addressing the rate of non-medically indicated cesarean deliveries, by Chen and colleagues, noted that the most effective interventions with the highest levels of evidentiary support were those targeting the provider and health system level (Chen et al., 2018). These findings were corroborated by a similar systematic review conducted by Betran and others, who also found that non-clinical interventions targeting provider attitudes and beliefs and models of care were suggested to be effective in reducing cesarean deliveries or prolonging physiological labor (Betrán et al., 2018). In addition the systematic reviews of existing interventions, Kingdon and colleagues conducted a systematic review of studies focusing on interventions to reduce cesarean delivery rate from 17 countries around the world between 1993-2016 to identify potential barriers or facilitators to the implementation of clinical interventions to reduce cesarean deliveries (Kingdon et al., 2018). The authors identified three distinct themes 1) health system, organizational, or structural factors, 2) human and cultural factors, and 3) mechanisms of effect to achieve change factors (Kingdon et al., 2018). Factors within these themes which were particularly impactful on implementation efforts included not aligning intervention with cultural norms, power differentials, and stakeholder commitment (Kingdon et al., 2018).

Population Health Impact

There is a paucity of evidence suggesting that the current rate of low-risk NTSV cesarean deliveries provides additional benefits to mothers and infants. On the contrary, research suggests that low-risk cesarean deliveries increase the risk of maternal morbidity and mortality. As evidenced above, addressing the rate of low-risk cesarean deliveries is an “upstream” approach to reducing maternal and neonatal morbidity and mortality, improving quality of care, and decreasing excessive health care expenditures.

By lowering the rates of low-risk non-medically indicated cesarean deliveries, the rates of severe acute maternal morbidity events, placental disorders, uterine rupture, and more (Belfort et al., 2010; Clark & Silver, 2011; Curtin et al., 2015; Henke et al., 2014; Kozhimannil, Law, et al., 2013; Mylonas & Friese, 2015; Sandall et al., 2018; Silver, 2010; Skeith et al., 2018; Spong et al., 2012). Further, rates of intensive care admission, and readmission within 6 weeks post-partum can also be addressed by lowering the rate of low-risk cesarean deliveries (Belfort et al., 2010; Curtin et al., 2015; Jenabi et al., 2020; Kozhimannil, Law, et al., 2013; Sandall et al., 2018). Additionally, lowering the rates of low-risk cesarean deliveries can concurrently impact the rates of asthma, respiratory distress syndrome, and childhood obesity all of which have been associated with cesarean delivery (Matevosyan, 2015; Mylonas & Friese, 2015; Pei et al., 2014; Sandall et al., 2018; Sitarik et al., 2020). Intervening to reduce the rates of low-risk cesarean deliveries also has the potential to improve the quality of care received. Overutilization of cesarean sections can lead to poorer health outcomes, lower reported quality of care, and higher healthcare expenditures as well as contributes to the pattern of health care inequity evidenced across the country and the world (Fisher & Welch, 1999; Hoxha et al., 2019; Matevosyan, 2015; Oakes et al., 2019; Roth & Henley, 2014; Shaw et al., 2016; Wennberg, 2004). Addressing the rates of low-risk cesarean deliveries could help, in part, to break the pattern of health care inequity that defines the variation in cesarean delivery rates and reduce health disparities.

Long-term Goals

The long-term goal of this dissertation is two-fold. First, to provide evidence as to the importance of NTSV cesarean deliveries as a major public health issue. Second, to illustrate the current variation of NTSV and elective cesarean deliveries in the U.S. and Appalachia, a culturally distinct sub-region of the U.S. It is the author's hope that this information can also be utilized to inform the develop of future interventions aimed at reducing the rate of NTSV and elective cesarean deliveries by illustrating the scope of the issue and potential modifiable risk factors.

Why Appalachia?

Appalachia extends from Mississippi to New York and consists of approximately 420 counties, 8 independent cities, and 205,000 square miles (*The Appalachian Region - Appalachian Regional Commission*, n.d.). Approximately 13% of all counties in the U.S. are within the Appalachian region (Hale et al., 2022). Additionally, 42% of Appalachia's population lives in a rural setting compared to 20% of the overall U.S.'s population (*The Appalachian Region - Appalachian Regional Commission*, n.d.). The Appalachian region of the U.S. is not only culturally distinct region but has also been shown in recent literature to be disproportionately burdened by poor health outcomes and limited access to healthcare resources. Disparities in health outcomes in Appalachia have been well documented (Hale et al., 2022; Marshall et al., 2017; Meit et al., 2017a; G. K. Singh et al., 2017; *The Appalachian Region - Appalachian Regional Commission*, n.d.; Thompson et al., 2021). Factors contributing to these disparities in Appalachia include geographic isolation, limited economic mobility, persistent poverty, and challenges in creating access to providers and affordable health care services (Beeson et al., 2014; Marshall et al., 2017; Meit et al., 2017a; G. K. Singh et al., 2017; *Socioeconomic Overview of the Appalachian Region - Appalachian Regional Commission*, n.d.;

The Appalachian Region - Appalachian Regional Commission, n.d.). Research indicates that Appalachian women, in particular, are disproportionately burdened by poor health outcomes and higher proportions of health risk factors (G. K. Singh et al., 2017; Thompson et al., 2021). Further, due to the rural nature of the region women in Appalachia are more likely to initiate prenatal care later in pregnancy, have pregnancy complications, and have increased risk of severe maternal morbidities (Hale et al., 2022; Hansen & Moloney, 2020; Lisonkova et al., 2016; Lu et al., 2003). These issues are only exacerbated with the recent loss of obstetric services in rural communities due to hospital closures (Hansen & Moloney, 2020; Kozhimannil et al., 2018).

The Appalachian region is further divided into five sub-regions, Southern, South Central, Central, North Central, and Northern. Predominantly, previous research has focused on health outcomes at the larger regional level, however, this has likely ignored important characteristics of sub-regional populations and health care systems which drive the variations in health outcomes. This notion is supported by recent research at the sub-regional level has illustrated that there is substantial variation in health outcomes across the five sub-regions (Hale et al., 2022; Meit et al., 2017a). As such, this dissertation seeks to add to this growing body of knowledge by exploring the variations in NTSV and elective cesarean sections within the sub-regions relative to Appalachia as a whole and non-Appalachia.

Project Aims

Aim 1: Examine the variation in nulliparous, term, singleton, vertex (NTSV) and elective cesarean deliveries in the United States from 2016-2020

Hypothesis 1.1: The rates of NTSV and elective cesarean deliveries will be higher among more affluent high-resource areas compared to low-resource areas.

***Aim 2*: Examine the extent to which the variation in NTSV and elective cesarean deliveries in the United States is mirrored in the Appalachian sub-regions**

Hypothesis 2.1: The rates of NTSV and elective cesarean deliveries will be lower in the Appalachian sub-regions relative to non-Appalachia.

Hypothesis 2.2: The rates of NTSV and elective cesarean deliveries will be highest in Northern Appalachia and lowest in Central Appalachia relative to the other Appalachian sub-regions.

Competencies

Foundational: Data and Analysis

1. Explain qualitative, quantitative, mixed methods and policy analysis research and evaluation methods to address health issues at multiple (individual, group, organization, community, and population) levels.

Foundational: Programs and Policies

15. Integrate knowledge of cultural values and practices in the design of public health policies and programs.

Foundational: Education and Workforce Development

19. Deliver training or educational experiences that promote learning in academic, organizational and community settings.

Foundational: Leadership Management and Governance

4. Propose strategies for health improvement and elimination of health inequities by organizing stakeholders, including researchers, practitioners, community leaders, and other partners.

5. Communicate public health science to diverse stakeholders, including individuals at all levels of health literacy, for purposes of influencing behaviors and policies.

Health Services Management and Policy

2. Integrate individual health information, population health measures and community resources to redesign health service delivery and improve population health.

3. Assess the effectiveness of public health and healthcare services aimed at improving population health using applied research methods.

4. Analyze patterns of health services utilization, costs, and outcomes and health system performance using applied research methods.

Stakeholder and Practice Partner Engagement Plan

A critical component of meeting the two-fold purpose of this dissertation, mentioned above, is dissemination of the findings of the following studies to pertinent partners and stakeholders interested in reproductive health and women's health outcomes. Broadly, relevant stakeholders who would be interested in the study of low-risk cesarean deliveries include women and their families, healthcare organizations, public and private organization's focused on women's health and maternal child health, public and private insurers, employers, and women's health researchers. More specifically within the Northeast Tennessee, one example of such stakeholder is Ballad Health, an integrated health system who, in conjunction with the state government, is making active strides to improve population health. Dissemination products will be shared directly with interested stakeholders and more broadly through publication in peer-reviewed journals.

For this dissertation, I propose the dissemination of three field-based products to key stakeholders and practice partners in Appalachia, as well as interested parties outside of Appalachia. The proposed field-based products are 1) an evidence matrix, 2) a manuscript detailing the research efforts to address Aims 1 and 2, and 3) an issue brief on low-risk cesarean deliveries. An evidence matrix is a mapping tool that can be utilized to organize and synthesize the current body of literature on a given topic in the hopes of identifying gaps in knowledge and prioritizing future research (Anstee et al., 2011). The evidence matrix will serve as an overview of the current body of scholarly literature on low-risk NTSV cesarean deliveries in the United States and serve as a primer for the second and third dissemination products. The manuscript will address Aim 1 and 2 and will be disseminated via peer-reviewed journal, such as the Journal of Appalachian Health. The final product, the issue brief, will report on the findings of the analysis from Aim 1 and 2, with specific emphasis on the policy implications and will be geared towards stakeholders such as healthcare organizations, employers, public and private insurers.

Chapter 2. Background and Significance

Introduction

Cesarean deliveries are the most commonly performed operative procedure and most common cause for hospitalization in the United States (U.S.) (Boyle & Reddy, 2012; Haberman et al., 2013; Kozhimannil, Thao, et al., 2016; Sung & Mahdy, 2020; Weimer et al., 2019). Low-risk cesarean deliveries, defined as the cesarean deliveries of singleton pregnancies to first time mothers presenting at term in the vertex position without any medically indicated need (NTSV), are an important public health issue in the United States (U.S.). Variation in the rate of NTSV cesarean deliveries suggests a lack of clear rationales for this method of delivery, an issue that warrants further attention. Each year, approximately one in three infants will be delivered via low-risk cesarean delivery (Martin et al., 2021; Osterman & Martin, 2014b). The rate of low-risk cesarean deliveries has implications on health care outcomes, quality, and expenditures which highlights the existing disparities in maternal health in the U.S. Low-risk cesarean deliveries have been associated with short and long-term health consequences for mothers and infants (Henke et al., 2014; Kilpatrick & Ecker, 2016; Matevosyan, 2015; Mylonas & Friese, 2015; Sandall et al., 2018; Weimer et al., 2019). Further, evidence suggests that both underutilization and overutilization of cesarean deliveries are associated with poorer health outcomes, higher health costs, and lower reported quality of care (Fisher & Welch, 1999; Hoxha et al., 2019; Oakes et al., 2019; Roth & Henley, 2014; Shaw et al., 2016; Wennberg, 2004). However, the appropriate rate of cesarean deliveries is difficult to estimate as it will vary according to multiple factors related to both the characteristics of the mother and the characteristics of the healthcare system (Spong et al., 2012). Addressing the rates of low-risk cesarean deliveries is an upstream approach to improving the health of mothers, infants, and families across the U.S.

Andersen's Healthcare Utilization Model

In order to more fully understand factors contributing to the variation in low-risk nulliparous, term, singleton, vertex (NTSV) cesarean deliveries, utilization will be conceptualized and organized using the Andersen Healthcare Utilization Model. The Andersen Healthcare Utilization Model is a well-known and widely applied model that integrates individual and broader contextual determinants to explain health services seeking behaviors (Babitsch et al., 2012). The Andersen Healthcare Utilization Model, developed in the late 1960s by Ronald Andersen, Lu Ann Aday, and colleagues, was created to conceptualize the reasons which predispose families to use health services, to quantify equitable access to health care, and to provide support for the development of legislation and policies to increase equitable access to health care services (Andersen, 1995). Andersen and colleagues purposed that the use of healthcare services was "a function of their predisposition to use services, factors which enable or impede use, and their need for care" (Andersen, 1995). There are three major components which constitute the Andersen Healthcare Utilization Model 1) predisposing characteristics, 2) enabling characteristics, and 3) need factors (Andersen, 1995). These components can be conceptualized at the individual and contextual level (Andersen, 1995; Andersen et al., 2011; Babitsch et al., 2012). The contextual level can refer to data aggregated above the individual level and can include the community an individual lives in, the healthcare organizations available to them, and broader socio-political contexts which may influence health and health care

(Andersen, 1995; Andersen et al., 2011; Babitsch et al., 2012). Predisposing characteristics include demographics, social factors, and beliefs. At the individual level demographics refer to the potential biological factors which may predispose a person to need health services, whereas at the contextual level demographic characteristics refer to the composition of the community falling into a given category and how that composition may influence the availability of health resources (Andersen, 1995; Andersen et al., 2011; Babitsch et al., 2012). Social characteristics, such as education, race/ethnicity, and employment status, at the individual level are factors which predict an individual's ability to address health issues as they arise. At the contextual level, social factors refer to community level factors which facilitate or impede an individual's ability to seek health services and, more broadly, an individual's health (Andersen, 1995; Andersen et al., 2011; Babitsch et al., 2012). Beliefs at the individual level include a person's knowledge, attitudes, and values which influence their perception of their health and need of health services. On the contextual level, beliefs assess cultural norms, community values, and political landscapes which influence perceptions of health services (Andersen, 1995; Andersen et al., 2011; Babitsch et al., 2012).

Enabling characteristics are those which "facilitate or impede use of services" (Andersen et al., 2011). On the individual level, enabling characteristics are related to factors which allow an individual to finance the use of health services. Common examples of individual level enabling characteristics include income, insurance coverage, employment status (Andersen et al., 2011; Babitsch et al., 2012). At the contextual level, enabling characteristics refer to organizational and structural factors and can include policies, the availability and distribution of health care facilities and resources, as well as the types of providers within the community

(Andersen et al., 2011; Babitsch et al., 2012). Need characteristics refer to an individual's perception of their need for health services and also encompasses the evaluated need for services by a healthcare provider (Andersen et al., 2011). Perceived need characteristics are predominantly determined by socio-cultural factors include education and ethnicity as well as by an individual's health beliefs (Andersen et al., 2011). Common examples of individual level evaluated need include objective health measures such as prior diagnoses, patient's temperature, and blood count levels to name a few (Andersen et al., 2011). Whereas environmental characteristics are sometimes allocated under contextual need factors, for the purposes of this study environmental factors will be considered independently, in line with the late 1990s iteration of this model and encompass structural characteristics which influence an individual's predisposing and enabling characteristics. Examples of environmental factors include rurality, quality of housing, air and water quality (Andersen et al., 2011).

The Andersen Healthcare Utilization model will be employed as a framework for examining the current body of scholarly literature on cesarean deliveries in the United States. Common examples of environmental, predisposing, enabling, and need characteristics at the individual and contextual level were used to guide search term selection.

Geography, Institutional Characteristics, and Cesarean Deliveries

Across the U.S. there is as much as a fifteen-fold difference in low-risk cesarean deliveries (Kozhimannil, Law, et al., 2013), as such geography and community context play a substantial role in these variations. Current research illustrates that the widespread variation is predominantly driven by institutional characteristics (Boyle & Reddy, 2012; Weimer et al., 2019). Institutional characteristics associated with variations include location, number of acute care beds per capita, the number of obstetricians and gynecologists (OB/GYN) per capita, provider practice culture, patient volume, staffing capabilities and models, as well as policies surrounding early labor hospital admissions (Bailit, 2012; Henke et al., 2014; Vanderlaan et al., 2020). Evidence suggests that higher volume hospitals have higher cesarean delivery rates compared to lower volume health systems (Janakiraman et al., 2011). However, research on the relationship between geography, health systems characteristics, and low-risk cesarean sections is conflicting.

Influence of Hospital Volume

Geographically, rural regions of the U.S. are disproportionately burdened by lack of access to obstetric providers and facilities, which has been further exacerbated by recent hospital and health system closures (Vanderlaan et al., 2020). Research indicates that in 2014 approximately 54% of rural counties in the U.S. lacked any type of hospital-based obstetric services (Kozhimannil et al., 2020). Loss of hospital-based obstetric services continues to grow with another 3% of rural counties losing such services between 2014-2018 (Kozhimannil et al., 2020). Further, research has indicated that the ratio of obstetricians per 100,000 population was significantly lower in rural communities, 6.1 providers per 100,000, compared to urban communities, 13.7 providers per 100,000 (Lee et al., 2020). The lack of access to providers and care has been associated with increased prevalence of preterm birth and emergency department births in rural counties compared to urban counties (Kozhimannil et al., 2020; Kozhimannil, Thao, et al., 2016). Additionally, the current body of scholarly literature indicates that lower resource communities are at higher odds of cesarean delivery and increased risk for cesarean-related poor maternal health outcomes relative to higher resource communities (Sandall et al., 2018). Based on this, the expectation would be that rural counties have higher rates of low-risk cesarean deliveries compared to urban counties. In line with this expectation, a geospatial study of cesarean deliveries in Georgia by Vanderlaan and colleagues found that clusters of counties with high rates of cesarean deliveries tended to be in rural regions (Vanderlaan et al., 2020). It should be noted that a portion of the high-rate clusters are not rural counties. This suggests that variations in cesarean deliveries is only in part attributable to lack of resources (Vanderlaan et al., 2020).

Conversely, urban high-volume hospitals may be more likely to see women with higher obstetric risk (Janakiraman et al., 2011), which in turn would lead to the expectation that urban hospitals have higher rates of cesarean deliveries. This assumption is supported by Janakiraman and colleagues who found that hospitals with the highest volume of deliveries per year, greater than or equal to 1700 births, had higher rates of cesarean delivery compared to lower volume hospitals (Janakiraman et al., 2011). Janakiraman and colleagues also noted that these high volume hospitals less likely to be rural compared to low volume hospitals (Janakiraman et al., 2011). Further, in an examination of the influence of hospital volume on low-risk cesarean deliveries, Clapp and others found that women who delivered in urban high-volume hospitals had higher odds of cesarean delivery compared to women in low-volume rural hospitals (Clapp et al., 2018). The authors, in line with the aforementioned expectation, noted that the difference in the odds of cesarean delivery by volume was attributed in part to the fact that low-volume hospitals were more likely to see publicly insured patients with fewer comorbidities (Clapp et al., 2018). It should be noted that the association between hospital volume and cesarean delivery rates was no longer significant after controlling for individual and institutional level characteristics (Clapp et al., 2018). Similarly, in an examination of the trends in low-risk cesarean delivery between 2002 and 2010 found that while the rates of low-risk and non-medically indicated cesarean deliveries increased in both rural and urban settings, rural hospitals had lower rates of low-risk and non-medically indicated cesarean deliveries compared to their urban counterparts (Kozhimannil, Hung, et al., 2014b).

Broadly, while lower volume health systems and providers are at increased risk for maternal complications, higher volume health systems and providers are at increased risk for cesarean deliveries. This is attributed in part to differences in patient level characteristics, particularly insurance coverage and prevalence of existing risk factors, between low and high-volume health systems (Janakiraman et al., 2011). It should be noted that higher volume hospitals have better health outcomes compared to low volume hospitals, this is attributed to provider characteristics, specifically that providers have greater experience providing complex care, as well as to structural characteristics of the hospital that are linked to improved quality of care (Urbach & Baxter, 2004). However, the research regarding the relationship hospital and physician volume and maternal outcomes has been conflicting and limited in generalizability (Kozhimannil, Thao, et al., 2016).

Influence of Provider Volume

Physician patient volume, in addition to hospital volume, has also been implicated as a factor contributing to the substantial variation in cesarean delivery rates across the U.S. In a longitudinal analysis of births at a major medical center in New York, McClelland and colleagues found that cesarean delivery rate was inversely related to provider volume, meaning that physicians who performed higher numbers of deliveries also had lower cesarean delivery rates compared to physicians who performed fewer deliveries (McClelland et al., 2017). In line with the findings of McClelland and colleagues, Clapp and others found in a retrospective cohort study of births between 2000 and 2012 at a single large academic hospital, that NTSV mothers whose physicians who delivered less than 60 infants a year were at two times higher odds of cesarean delivery compared to NTSV mothers whose physician delivered greater than 60 infants per year (Clapp et al., 2014). In terms of the relationship between geography and provider volume, Janakiraman and colleagues conducted an analysis of the Nationwide Inpatient Sample from 2007, found that low-volume providers tended to be located in rural areas and that these providers had higher rates of perinatal complications compared to high volume facilities (Janakiraman et al., 2011).

Influence of Provider Characteristics

Provider characteristics including demographic characteristics, provider training, and provider practice patterns have been shown to be influential on the low-risk cesarean delivery rate (Bailit, 2012; Coonrod et al., 2008; Hoxha et al., 2020; Kozhimannil, Law, et al., 2013;

McClelland et al., 2017). Provider demographics specifically provider gender has been shown to have a significant impact on cesarean delivery rates (Hoxha et al., 2020; McClelland et al., 2017). Research indicates that female providers are less likely to perform cesarean sections relative to their male counterparts (Hoxha et al., 2020; McClelland et al., 2017).

Particularly influential on the rates of cesarean delivery is a provider’s training and specialty (Carlson et al., 2020; Damiano et al., 2020; McClelland et al., 2017). The vast majority of births, 98.4%, in the U.S. take place in a hospital and are performed by either physicians including medical doctors (MD) or osteopaths (DO), certified nurse midwife, certified midwife, or other midwife (National Academies of Sciences, 2020). Approximately 91% of births are attended by a physicians, and the remaining proportion of hospitals births are delivered by a midwife (National Academies of Sciences, 2020). Research illustrates the women who receive care from obstetricians have higher rates of low-risk cesarean deliveries compared to women who receive care from midwives (Carlson et al., 2020; Damiano et al., 2020). The literature also suggests that Obstetricians and Maternal Fetal Medicine specialists are associated with higher odds of cesarean delivery compared to midwives (Carlson et al., 2020; Damiano et al., 2020; McClelland et al., 2017). Further, midwife-led care has been associated with low proportions of medical intervention during labor and delivery (Sutcliffe et al., 2012). The differences in cesarean delivery rates are attributed in part to the fundamental differences in the types of patients who are served by either obstetricians or midwives. Women who see obstetricians as their primary prenatal care provider are more likely to have a higher-risk pregnancies compared to midwives (Bailit, 2012; Stoll et al., 2018; Sutcliffe et al., 2012). As such, patient level characteristics may be a more significant driver of cesarean delivery variation compared to provider characteristics. In a survey of members of the Society for Maternal Fetal Medicine and the American Urogynecologic Society, Wu and colleagues found that while approximately 65.4% of surveyed providers reported that they would perform an elective cesarean delivery, and further that survey of members of the American Urogynecologic Society were 3.4 times more likely to perform elective cesarean deliveries (Wu et al., 2005). This is in part attributable to provider's professional focus and training, i.e. urogynecologists are more likely to prioritize the prevention of pelvic floor damage, a common complication of vaginal delivery (Wu et al., 2005).

Physician practice patterns, as influenced by their training and attitudes, are also a major driver of the variations in low-risk cesarean deliveries in the U.S. (Kozhimannil, Law, et al., 2013; MacDorman et al., 2008). Physicians rely heavily on subjective indications of need for cesarean delivery, i.e., fetal heart tracings, arrest of dilation, etc. as there are few absolute indications of need for a cesarean delivery (Spong et al., 2012). These subjective measures are heavily influenced by the beliefs, attitudes, and preferences of the provider (Spong et al., 2012). In a survey of maternal healthcare providers in California, White VanGompel and colleagues found that provider attitudes were significantly associated low-risk cesarean delivery rates (White Vangompel et al., 2018). Additional physician-related characteristics which have been implicated in the increasing rates of cesarean deliveries include lack of access to facilities and resources, health care practice coverage, lack of cooperation amongst professionals, current reimbursement structure, and the changing medico-legal environment (Abenhaim et al., 2007; Barber et al., 2011; Henke et al., 2014; Kozhimannil, Law, et al., 2013; Mushinski et al., 2021; Mylonas & Friese, 2015; Panda et al., 2018; Reyes & Rosenberg, 2019). Contrary to expectation, years of practice found to be associated with variations in cesarean delivery rates (Ghetti et al., 2004; Kenton et al., 2005).

Influence of Staffing Capacity and Staffing Patterns

Another important institutional characteristics which has been associated with low-risk cesarean delivery rates are staffing capacity and patterns (Bailit, 2012). Evidence suggests that hospitals who staff in house obstetricians, maternal fetal health specialists, anesthetists, and obstetric residents had lower risk of cesarean delivery (Coonrod et al., 2008).

Currently the U.S. healthcare system is inundated with a broader variety of staffing models, two of the most predominant being the traditional model and the laborist model (Bailit, 2012). The traditional model, also known as the private practice model, refers to a pattern of practice in which physicians are scheduled to a wide variety of both clinical and administrative duties for a number of consecutive days. The traditional model generally only allows for coverage from other physicians on the weekends (Bailit, 2012). Critics of the traditional model believe that it leads physicians to change their practice behaviors to “preserve” their family time and sleep schedules (Bailit, 2012). Evidence in the current body of scholarly literature suggest that physicians may perform cesarean sections in the early stages of labor or delay the use of labor inducing drugs overnight to fit deliveries into specific work hours (Bailit, 2012; Brown, 1996; Burns et al., 1995; Roth & Henley, 2014). Current observational research supports this criticism, indicating that the rates of low-risk cesarean delivery are highest during the day and lower in the evenings (Son et al., 2020). However, another observational study of the impact of time of day on the risk of cesarean delivery found that among nulliparous births the rates of cesarean deliveries were higher in the evening hours (Haberman et al., 2013). Additionally, evidence suggests that cesarean deliveries were less likely over the weekend compared to weekdays (Haberman et al., 2013).

The laborist model, on the other hand, is a pattern of practice in which a physician is scheduled for up to 24 hours shifts to cover labor and delivery exclusively with no additional administrative duties (Bailit, 2012). In a retrospective review of a tertiary care hospital who implemented a laborist program for maternity care, Iriye and colleagues found that the utilization of a full-time laborist was associated with a significant reduction in the cesarean delivery rate compared to the traditional model, 33.2% vs. 39.2% (Iriye et al., 2013). Iriye and colleagues's findings were further supported by Nijagal and others who found in a retrospective cohort study of women who either received care under the traditional model or a midwife/laborist model, that NTSV women who received care under the laborist model were significantly less likely to deliver via cesarean compared to women who received care under a traditional model of care (Nijagal et al., 2015). In a prospective cohort study of a community hospital who implemented a laborist model, Rosenstein and colleagues noted that the community hospital NTSV cesarean delivery rate among privately insured women was significantly reduced following the implementation of the laborist model from 31.7% in 2005 to 25.0% in 2014 (Rosenstein et al., 2015). Conversely, in a study of approximately 250 childbirth hospitals in California, it was found that there was no significant differences in cesarean delivery rates in hospitals with laborist models or those with traditional models (Feldman et al., 2015).

Rural health systems face additional challenges in staffing capacity and patterns. Rural counties tend to have lower healthcare resource density and women in rural communities tend to have to travel farther to access obstetric services. The Centers of Medicare and Medicaid Services (CMS) noted that over 10% of rural women had to travel more than 100 miles to obtain obstetric services (Medicare & Services, 2019). Further, the current medico-legal climate and rising insurance premiums has alienated physicians from specializing in obstetrics exacerbating existing inequities in the distribution and availability of providers (Mylonas & Friese, 2015; Prasad et al., 2018). Consequently, the growing trend over the last decade is for hospitals to compensate for this lack of specialists by employing family physicians to maintain and provide obstetric services (Prasad et al., 2018). As family physicians are not trained in operative delivery, they have been shown to be less likely to perform cesarean deliveries (Prasad et al., 2018). Prasad and colleagues recently assessed the relationship between obstetric procedure utilization and hospital physician employment patterns to determine the influence of that relationship on cesarean delivery rates (Prasad et al., 2018). They found that family physicians were hired to carry out obstetric care in lower birth volume rural hospitals compared to higher volume rural hospitals who tended to staff obstetricians (Prasad et al., 2018). Hospitals which staffed both family physicians and obstetricians to provide perinatal care were shown to be associated with increased low-risk cesarean delivery rates compared to hospitals who only staffed either family physicians or obstetricians (Prasad et al., 2018). Further, in an examination of those hospitals which employ both family physicians and obstetricians, Prasad and colleagues found that with increasing proportions of obstetricians employed there were also significant increases in the rates of low-risk cesarean deliveries and non-medically indicated labor induction compared to hospitals who staffed larger proportions of family physicians (Prasad et al., 2018).

Influence of Hospital Ownership

A final institutional characteristic which has been implicated as a contributing factor to the rising rate of cesarean deliveries over the last several decades is hospital ownership (Boyle & Reddy, 2012; Weimer et al., 2019). The literature has shown that cesarean delivery rates are positively associated with hospital ownership, specifically that cesarean delivery rates are higher in for-profit, or proprietary, institutions compared to non-profit institutions (Clarke & Tafil, 1995; McKenzie & Stephenson, 1993; Porreco & Thorp, 1996). A recent systematic analysis of the association between hospital ownership and cesarean deliveries by Hoxha and colleagues supported these findings and added that, on average, women delivering in private for-profit hospitals were at a 1.4 times higher odds of having a cesarean delivery compared to women who delivered in non-profit institutions (Hoxha, Syrogiannouli, Luta, et al., 2017). Conversely, Clapp and others did not find a statistically significant relationship between hospital ownership and cesarean delivery rates in their 2018 study (Clapp et al., 2018). Further contributing to the variations is the predominant structure of health care reimbursement in the U.S., which reimburses operative deliveries at higher rates compared to vaginal deliveries, leading to potential patterns of overuse (Hoxha, Syrogiannouli, Braha, et al., 2017; Roth & Henley, 2014; Sakai-Bizmark et al., 2021). At the health system level, increasing hospital and physician profit is associated with substantial increases in cesarean delivery rate (Foo et al., 2017). Further, a recent study indicated that women were at a significantly increased odds of cesarean delivery in hospitals with higher profit margins per procedure compared to hospitals with lower profits per procedure (Sakai-Bizmark et al., 2021).

The conflicting findings on the relationships between geography and institutional characteristics reflect the complicated and multifaceted nature of NTSV cesarean delivery rates. Further, it indicates that geography and health systems characteristics alone does not fully explain the substantial variation in low-risk cesarean delivery rates. As such it is important to examine additional predisposing, enabling, and need characteristics which may also influence the variation in low-risk cesarean deliveries in addition to the environmental characteristics.

Demographics, Social Factors, Beliefs and Cesarean Deliveries

Predisposing characteristics which have been shown to be associated with overall and low-risk cesarean deliveries can be examined at the individual level, health systems level, and the broader community level. At the individual level, maternal demographics characteristics such as age, race/ethnicity, educational attainment, obesity, timing of prenatal care, and health beliefs are the major drivers of variation in cesarean deliveries (Coonrod et al., 2008; Haberman et al., 2013; Loke et al., 2015; Poobalan et al., 2009). The distribution of predisposing characteristics varies by rurality. Relative to their urban counterparts, rural women of reproductive age were more likely to have less education, lower income, unemployed, and non-Hispanic white (Lee et al., 2020).

Influence of Demographic Characteristics

Advanced maternal age, defined as greater than or equal to 35 years, has been shown to be associated with increased risk for more severe maternal morbidities and poor perinatal outcomes (Lean et al., 2017; Lisonkova et al., 2016; Londero et al., 2019). Further, advanced maternal age has been shown to moderate the relationship between cesarean delivery and severe maternal morbidity (Korb et al., 2019). Advanced maternal age has been consistently shown to be a significant predictor of NTSV cesarean deliveries (Coonrod et al., 2008; Damiano et al., 2020; McClelland et al., 2017). Between 1996 and 2009, research indicated that women between the age of 40-54 years delivered via cesarean twice as often as women between the ages of 20-24 years (Boyle & Reddy, 2012). Further, in a national level study of NTSV births in the U.S. between 2016 and 2018, Andrikopoulou and colleagues found that the adjusted relative risk of having a low-risk NTSV cesarean delivery increased significantly with maternal age (Andrikopoulou et al., 2021).

Variations in cesarean deliveries by race/ethnicity have been well studied. Minority women and women of color are more likely to have a cesarean delivery compared to non-Hispanic white women (Andrikopoulou et al., 2021; Coonrod et al., 2008; Getahun et al., 2009; Kozhimannil, Hardeman, et al., 2013; Kozhimannil, Macheras, et al., 2014; Sebastião et al., 2016; Washington et al., 2012). Non-Hispanic black women are particularly inclined to deliver via cesarean section, this is predominantly attributed to higher prevalence of pregnancy-related risk factors among non-Hispanic black women relative to other race/ethnicities (Roth & Henley, 2014). Additional research found that among NTSV pregnancies, after adjusting for factors associated with cesarean delivery, that non-Hispanic black women were more likely to deliver via cesarean due to subjective measures of need, such as non-reassuring fetal heart tracings and failure to progress (Sebastião et al., 2016; Washington et al., 2012). Non-Hispanic white women, however, were more likely to deliver via cesarean for more objective measures, such as malpresentation (Washington et al., 2012). Conversely, other research suggests that Hispanic and Asian women have lower rates of cesarean deliveries compared to non-Hispanic white women (Getahun et al., 2009; Kozhimannil, Macheras, et al., 2014).

Educational attainment is a common predictor of health outcomes including perinatal outcomes. Between 1996-2003 cesarean delivery rates in the U.S., both primary and repeat, increased across all levels of educational attainment (Menacker et al., 2006). Increasing levels of educational attainment have been shown to be associated with lower odds of having a cesarean delivery (Roth & Henley, 2014). Another common explored potential predictor of perinatal and birth outcomes is prenatal care. However, the existing body of scholarly literature on the impact of prenatal care on birth outcomes is mixed (Corman et al., 2018). This lack of consistent findings has been primarily attributed to the widespread variations in not only the provision of prenatal care but also its quality and content (Corman et al., 2018). Further, individual level differences in physical and mental health can confound the impact of prenatal care on birth outcomes, such as cesarean deliveries (Corman et al., 2018). Additionally, the recommendations from the American College of Obstetricians and Gynecologists vary based on maternal health status, i.e., low-risk women can follow a reduced visit schedule (less than 14 prenatal visits) with no evidence of adverse consequences on maternal or infant health (Walker et al., 2001). Despite, the lack of clear evidentiary support of the association between prenatal care and cesarean deliveries the near total uptake of prenatal care among women in the United States makes it an important consideration for any maternal health outcome (Corman et al., 2018).

Influence of Health Beliefs

Health beliefs, attitudes, and knowledge are an important predisposing characteristics which can influence not only the use of health services but a woman's perception of need for these services (Andersen et al., 2011). In a study of births in Pennsylvania between 2009-2011, Attanasio and colleagues further explored the influence of prenatal attitudes on mode of delivery. Specifically, they sought to determine whether maternal attitudes towards vaginal delivery was associated with actual mode of delivery (Attanasio et al., 2017). Attanasio and colleagues found that women who reported positive prenatal attitudes towards vaginal delivery had lower odds of delivering via cesarean section (Attanasio et al., 2017). These findings, however, were only significant when considering non-Hispanic white women who were privately insured and had higher levels of educational attainment (Attanasio et al., 2017). Patient satisfaction with healthcare providers, specifically prenatal care providers, has also been shown to be associated with cesarean delivery rates. In a 2005 study, Cohen noted that women who had higher levels of patient satisfaction with their prenatal care provider had lower rates of cesarean delivery compared to women with lower levels of patient satisfaction (Cohen, 2005).

A growing, and controversial, explanation for the increasing rates of low-risk cesarean deliveries is due to maternal request (Viswanathan et al., 2006; Yamamoto, 2011). The factors that influence low-risk women to request a cesarean delivery are complex but are likely rooted in their personal knowledge, attitudes, and beliefs (Jenabi et al., 2020). Health beliefs, driven by social and cultural influences, around the role of the prenatal care provider and the need for medical or technological intervention further complicate the choice of delivery method (Miller & Shriver, 2012; Reyes & Rosenberg, 2019). Fear of childbirth, anxiety, prior birth experiences, avoidance of prolonged labor, and efforts to prevent maternal morbidities, specifically organ prolapse and urinary incontinence, are commonly cited rationales for maternal request of cesarean delivery without medical indication (Betrán et al., 2018; Jenabi et al., 2020; Romero et al., 2012). Additionally, convenience and peer group influences have also been implicated as reasons for requesting a non-medically indicated cesarean delivery (Penna & Arulkumaran, 2003). A cross-sectional study of women's knowledge regarding delivery method and cesarean delivery on maternal request found that knowledge about the association between vaginal delivery and maternal morbidities, as well as fear of labor pain were independently associated with cesarean delivery by maternal request (Dursun et al., 2011). A qualitative study of nulliparous Canadian mothers found that women relied predominantly on socio-cultural knowledge and beliefs when deciding to request a cesarean delivery (Munro et al., 2009). Further, for women who chose a cesarean delivery on maternal request utilized both medical information and informal birth stories in the decision-making process. Birth stories that included the use of medical and technological interventions and confirmed personal preferences for cesarean delivery were especially influential in decision-making (Munro et al., 2009). In studies of childbirth fear, nulliparous women who report childbirth fear are over three times as likely to deliver via non-medically indicated cesarean delivery (Stoll et al., 2018). Individual characteristics associated with increases in cesarean section by maternal request include educational attainment, household income, advanced maternal age, maternal obesity, and lower levels of religiosity (Jenabi et al., 2020). As such it will be pertinent to include these characteristics related to maternal request as they can be used to approximate complex health beliefs.

Influence of Social Norms and Structures

The overutilization of services can be influenced by longstanding social norms and values (Nagle & Samari, 2021). Specifically, social norms around structural sexism and racism (Nagle & Samari, 2021). The availability of resources within a given community directly influences an individual's ability to access and receive health care services making it an important predisposing characteristic. Structural sexism is defined as "systematic gender inequality in power and resources" (Homan, 2019; Nagle & Samari, 2021). Structural sexism exists across multiple levels including the individual, institutional, and population levels (Homan, 2019; Nagle & Samari, 2021). In the current literature on the subject, structural sexism has been associated a higher levels of self-reported health, as well as higher risk for chronic conditions (Homan, 2019; Nagle & Samari, 2021). Regarding birth outcomes, historically in the U.S. greater levels of societal value have been placed on the infant over the mother and as such institutional policies within the healthcare system have favored medical and technological interventions during labor regardless of the lack of evidence of improved outcomes or the preferences of the mother (Bates, 1994; Nagle & Samari, 2021). An aggregate population measure of structural sexism has been developed using publicly available secondary data from the American Community Survey, the Pew Research Center, the Guttmacher Institute, and the Center for American Women and

Politics (Homan, 2019; Nagle & Samari, 2021). This measure assesses and integrates political, economic, cultural, and reproductive policies which influence the differences in power and resources by gender (Homan, 2019; Nagle & Samari, 2021). Nagle & Samari utilized this measure to explore and quantify potential associations between population level structural sexism and low-risk cesarean deliveries (Nagle & Samari, 2021). They conducted a cross-sectional study of the 2018 birth certificate data and found that structural sexism was associated with higher odds of cesarean delivery after controlling for potential confounders (Nagle & Samari, 2021). Structural sexism and similar measures are important predisposing characteristics as it quantifies the influence of national and state level policies on women's health which influence women's access to reproductive health services and the availability of health resources.

Another important social construct to consider in the examination of maternal health outcomes is the idea of medical racism. Medical racism, defined as when a provider diagnostic decisions, treatments, and perceptions are influenced by a patient's race, continues to pervade medical practice patterns in the U.S. and further alienates minority populations from seeking healthcare (Davis, 2019; Serchen et al., 2020). Historically, the medical community within the U.S. has disproportionately marginalized and exploited African Americans for experimental purposes, particularly African American women (Nuriddin et al., 2020). This mistreatment has contributed substantially to health disparities seen today, due in part to the cultural mistrust of healthcare and healthcare providers within the African American community (Nuriddin et al., 2020). It can be postulated that the impact of medical racism may play a role in the substantial variations of cesarean delivery rates by race/ethnicity that are evident in the U.S. (Andrikopoulou et al., 2021; Coonrod et al., 2008; Getahun et al., 2009; Kozhimannil, Law, et al., 2013;

Kozhimannil, Macheras, et al., 2014; Roth & Henley, 2014; Sebastião et al., 2016; Washington et al., 2012). Further, women of color and their infants may be at a disproportionate risk for poorer perinatal health outcomes due to differential treatment on the basis of race/ethnicity. As such considering the structural components of a community, such as residential segregation, are an important consideration as they may contribute to continuing inequities in the access to and provision of care.

Facilitators and Barriers of Cesarean Section Utilization

Enabling characteristics which have been associated with overall and low-risk cesarean deliveries can be examined at the individual level, health systems level, and the broader community level. As aforementioned, enabling characteristics refer to factors which “facilitate or impede use of services”. At the individual level, this commonly utilized metrics to approximate enabling characteristics include insurance coverage, income, and employment (Andersen et al., 2011; Babitsch et al., 2012). At the health systems level enabling characteristics broadly parallel the previously discussed and include legal climate and institutional policies, as well as the availability of health care providers and services (Andersen et al., 2011; Babitsch et al., 2012).

Influence of Socioeconomic Resources

Socioeconomic status, independent of other common demographic measures, has been shown to be significantly associated with increased risk for low-risk cesarean delivery (Gould et al., 1989). Income is a particularly influential socioeconomic factor which is not only influential on health outcomes but also other socioeconomic factors such as insurance coverage, and educational attainment. There is substantial variation in the distribution of socioeconomic status across the U.S., rural counties area disproportionately represented among high poverty counties, defined as greater than or equal to 20% of the population living below the federal poverty level (Farrigan, 2020). Whereas 1 in 10 urban counties will be designated as high poverty, one in four rural counties are given that designation (Farrigan, 2020). Further, of the counties deemed extreme poverty or persistent poverty counties, defined as counties with a poverty rate of greater than or equal to 20% for over 30 years, were all rural counties (Farrigan, 2020). Studies of the relationship between socioeconomic status and cesarean deliveries in the United States indicate that cesarean delivery without medical indication is more common among high-income women (Coonrod et al., 2008; Gould et al., 1989; Roth & Henley, 2014). One factor that may be contributing to the higher rates of cesarean deliveries among women of higher socioeconomic status identified by Gould et al. is that complications of labor are more likely to be reported in affluent women compared to poor women (Gould et al., 1989). Based on this evidence, the high proportion of poverty among rural counties may attribute to lower rates of low-risk cesarean deliveries.

Marital status is an enabling characteristic to consider as it can represent the pooling of resources between two individuals, facilitating access to health care that, separately, may not exist. A systematic review of the relationship between maternal marital status and birth outcomes found that unmarried status was associated with increased risks of preterm birth, low birthweight, and small for gestational age births (Shah et al., 2011). In assessments of the relationship between maternal sociodemographic characteristics and delivery method, researchers have found no significant association between marital status and delivery method, including medically and non-medically indicated cesarean deliveries (Min et al., 2015; Witt et al., 2015). However, the limitations of the available metrics to assess marital status, potential misclassification of women's relationship status, and the limited focus of these studies may attribute to the non-significant association (Min et al., 2015). Despite the lack of clear associations in the current body of scholarly literature and the limitations of previous studies, the impact of marital status on other maternal and child health outcomes warrants its inclusion in the conceptual model.

Influence of Insurance Coverage

It is widely acknowledged that insurance coverage is a determinant of health outcomes. The importance of insurance coverage as a means of assessing access to and the timely receipt of healthcare services cannot be understated. In regard to birth outcomes, insurance coverage enabling utilization of perinatal care has been shown to be associated with better birth outcomes and better long-term health and well-being for mothers and infants (Daw et al., 2017; Partridge et al., 2012). Insurance coverage, however, is not consistent. Pregnancy, as well as the immediate post-partum period, can be a particularly unstable period of time for women leaving them at risk for gaps in coverage and consequently increased risk for poorer health outcomes (Daw et al., 2017). Daw and colleagues examined patterns of insurance coverage during the perinatal period among women who gave birth between 2005-2013 and found significant rates of insurance transition among women in the nine months before delivery and in the six months (Daw et al., 2017). Gaps or disruptions in insurance coverage have been shown to act as a barrier to care and to be associated with lower odds of having a regular source of health care and an increased odds of delaying care due to cost (Daw et al., 2017). Further, rates of insurance coverage vary on a number of factors, including geography. While rates uninsurance have been declining in recent years in both urban and rural counties, rural counties continue to have larger proportions of their population without insurance compared to urban counties (Cheeseman Day, 2019). The literature examining insurance coverage and cesarean delivery rates has been mixed, highlighting the complexity between payment source and cesarean delivery. Several recent studies note that privately insured women had a higher likelihood of delivering via cesarean section relative to publicly insured women (Andrikopoulou et al., 2021; Henke et al., 2014; Hoxha, Syrogiannouli, Braha, et al., 2017; Kozhimannil, Hung, et al., 2014a). Similarly in a 2011 study, Huesch found that women who were self-paying or publicly insured by Medicaid had a lower adjusted relative risk of delivering via cesarean section compared to women who were privately insured through commercial health organizations (Huesch, 2011). These findings were supported by Kozhimannil and colleagues who found that women whose births were covered by Medicaid were at a 9% lower odds of delivering via cesarean sections (AOR=0.91) compared to women whose births were covered by private insurers (Kozhimannil, Shippee, et al., 2013). Additionally, a recent systematic review of the relationship between insurance coverage and cesarean deliveries noted that women who lacked insurance coverage had a lower likelihood of delivering via cesarean compared to privately and publicly insured women (Hoxha, Syrogiannouli, Braha, et al., 2017). Conversely, another recent observational study at the health systems level found that among first-time mothers those with public insurance were at an increased risk of delivering via cesarean section compared to privately insured mothers (Haberman et al., 2013).

Insurance coverage can also dictate the ability to access alternative healthcare providers, such as midwives and doulas. The current body of scholarly research notes that women who receive care from doulas and/or midwives have significant lower rates of cesarean deliveries compared to women who see obstetricians, which is in part attributable to differences in differences in maternal risk profiles, i.e., obstetricians tend to treat women with higher risk pregnancies (Bailit, 2012; Carlson et al., 2020; Damiano et al., 2020; Stoll et al., 2018). Additionally, services provided by doulas have been shown to be a cost-effective approach to reducing the rate of non-medically indicated cesarean deliveries (Kozhimannil, Attanasio, et al., 2014). However, current reimbursement structures rarely cover the services of alternative prenatal care providers, which prevent women of color and women of lower socioeconomic status from accessing these services further exacerbating existing disparities (Kozhimannil, Attanasio, et al., 2014). While the literature does not indicate significant differences in the rates of women who actively utilize alternative prenatal care services based on payment source, women who are publicly insured or do not have insurance coverage are more likely to report the desire to utilize these services compared to privately insured women (Kozhimannil, Attanasio, et al., 2014).

Influence of Community and Health Systems Policy

At the community level, a potential barrier to the utilization of healthcare services, particularly obstetric services, is the current medico-legal climate. Evidence suggests that the ever evolving medico-legal environment has influenced the variations in cesarean delivery rates across the U.S. (McClelland et al., 2017). The last several decades has seen a shift in the provision of obstetric care in the U.S. towards more defensive, risk-averse practice patterns in order to deal with increasing medico-legal pressures (Abenhaim et al., 2007; Mushinski et al., 2021; Mylonas & Friese, 2015). Further, rising costs of malpractice insurance coverage and premiums have not only alienated providers from specializing in obstetrics but also disposes providers to utilize cesarean sections in response to the more subjective measures of need, such as fetal heart tracings (Barber et al., 2011; Mylonas & Friese, 2015). Additionally, obstetricians who are not well versed in operative vaginal deliveries, such as the use of forceps or vacuum during delivery, may elect to perform a cesarean delivery to avoid liability (Matevosyan, 2015).

At the institutional level, a major contributing factor in the widespread variation of cesarean deliveries in the U.S. is the lack of consistent guidelines for the provision of cesarean deliveries (Betrán et al., 2016; "Obstetric Care Consensus No. 1: Safe Prevention of the Primary Cesarean Delivery," 2014; Plough et al., 2017). In a survey of American College of Obstetricians and Gynecologists Fellows found that of respondents over 90% noted that their institution did not have policies regarding cesarean delivery by maternal request, another albeit controversial driver of the increases in low-risk cesarean deliveries (Bettes et al., 2007). Of those who reported that their institution did have a policy on cesarean delivery by maternal request the majority of those policies, over 70%, were supportive of this practice with such conditions as informed consent and extensive counseling (Bettes et al., 2007). Plough and colleagues, in a study of the association between management practice and low-risk cesarean deliveries in the U.S., found that women who deliver in hospitals with proactive management, defined as management practices which attempt to anticipate and mitigate potential challenges before they arise, were at a significantly higher risk of delivering via low-risk cesarean compared to women who delivered in a hospital with a reactive management practices (Plough et al., 2017). Policies around early labor admission and labor induction have also been implicated as factors association with the variation in cesarean deliveries in the U.S. (Boyle & Reddy, 2012; Coonrod et al., 2008; Rivo et al., 2018) Research indicates a strong association between induction rates and early labor admission rates and cesarean delivery rates (Boyle & Reddy, 2012; Coonrod et al., 2008; Main et al., 2006; Rivo et al., 2018). In a study conducted by Main and colleagues, approximately 53% of the variation in low-risk cesarean delivery rates was attributable to rates of early labor admission and labor induction (Main et al., 2006). The influence of health system, and more broadly national, policy on low-risk cesarean delivery rates cannot be understated and consequently has led to the development of policy and non-clinical interventions.

Perceived and Evaluated Need for Cesarean Delivery

Need characteristics refer to an individual's perception of their need for health services and also encompasses the evaluated need for services by a healthcare provider (Andersen et al., 2011). Perceived need characteristics are predominantly determined by socio-cultural factors include education and ethnicity as well as by an individual's health beliefs (Andersen et al., 2011). Common examples of individual level evaluated need include objective health measures such as prior diagnoses, patient's temperature, and blood count levels to name a few (Andersen et al., 2011). Individual level need focuses on women's perceived needs, whereas health system level need refers to the evaluated need from the perspective of the health care provider (Andersen et al., 2011).

Perceived Need

One way to estimate a woman's perceived need for cesarean delivery is to examine cesarean deliveries by maternal request. Cesarean delivery by maternal request has emerged as a major contributor to the growing rates of low-risk cesarean deliveries (Viswanathan et al., 2006; Yamamoto, 2011). As defined by Andersen and colleagues, cesarean delivery on maternal request is an individual level need characteristic because it encompasses both individual health beliefs and the socio-cultural factors which influence those beliefs (Andersen et al., 2011). Fear of childbirth, timing of birth, anxiety, avoidance of prolonged labor, and prevention of maternal morbidities are commonly cited reasons for cesarean delivery on maternal request (Betrán et al., 2018; Jenabi et al., 2020). While childbirth fear and the cultural influences which predispose a woman to such a fear are not well studied in the U.S., studies conducted in Europe and Canada have shown that childbirth fear is associated with a significantly more likely to deliver via cesarean section without medical indication, specifically 3.3 times more likely (Stoll et al., 2018). Similarly in a study of college-aged U.S. women, women who reported a preference for delivering via cesarean section were twice as likely to report extreme fear of childbirth and four times more likely to report that their fear influenced their preference (Reyes & Rosenberg, 2019). Preference for cesarean delivery on maternal request over vaginal delivery may also stem from the potentially incorrect perceptions that cesarean sections are more efficient, have less impact on their body, are a good preemptive measure to avoid emergency interventions, and are more convenient (Jenabi et al., 2020; Reyes & Rosenberg, 2019). There are several limitations of utilizing cesarean delivery on maternal request as a proxy for women's perceived needs. First, the actual prevalence of cesarean delivery by maternal request is difficult to accurately calculate because it is not clearly recorded or indicated on health records or surveys (Yamamoto, 2011). Second, maternal request does not fully account for the of the increases in cesarean delivery rates and often underestimates the health care provider's influence on decision making (Barber et al., 2011; Bodner et al., 2011; McCourt et al., 2007; Mylonas & Friese, 2015; Weimer et al., 2019). An important influence on a woman's health beliefs, knowledge, and attitudes is culture and religion. Research suggests that women's choices regarding childbearing and birth are dependent on which actions are less "risky", these decisions are predominantly shaped by their cultural belief system (Miller & Shriver, 2012). Religiosity specifically can shape a woman's perception of risk and consequently her perceived need (Miller & Shriver, 2012). Research indicates that women with lower levels of religiosity are more likely to request a cesarean delivery compared to women with higher levels of religiosity (Jenabi et al., 2020).

Evaluated Need

There are few absolute indications of the need for cesarean delivery and as such much of the decision making around cesareans are based on subjective measures of need (Spong et al., 2012). These subjective measures are heavily influenced by health-system and physicians (Spong et al., 2012). Absolute, or clinical, factors associated with the need for cesarean delivery generally relate to the changing risk profiles among women (Kaimal & Kuppermann, 2012; Panda et al., 2018; Reyes & Rosenberg, 2019; Roth & Henley, 2014; Weimer et al., 2019). Clinical risk factors associated with cesarean deliveries in nulliparous women include gestational age, preeclampsia, maternal weight, diabetes, infant presentation, extreme birthweight, change in cervical dilation within two hours of hospital admission (Chu et al., 2007; Patel et al., 2005;

Wilkes et al., 2003). Additionally, labor induction has been associated with cesarean delivery risk, however the current literature on the exact influence of labor induction has been mixed (Caughey et al., 2009; Kjerulff et al., 2017; Middleton et al., 2020; Mishanina et al., 2014; Vahratian et al., 2005; Wennerholm et al., 2009; Wood et al., 2014). Subjective measures, based on a provider's responses to ongoing labor management, of risk for cesarean delivery include arrest of dilation, fetal distress, and fetal heart tracings (Kaimal & Kuppermann, 2012; Panda et al., 2018; Reyes & Rosenberg, 2019; Roth & Henley, 2014; Weimer et al., 2019). Rising insurance premiums have attributed to higher rates of low-risk cesarean deliveries by causing providers to rely more heavily on these measures in the decision-making process (Barber et al., 2011). Provider specific characteristics such as personal beliefs, attitudes, preferences, and training also influence their evaluations of medical need for cesarean section (Barber et al., 2011; Haberman et al., 2013; Henke et al., 2014; Janakiraman et al., 2011; Kaimal & Kuppermann, 2012; Panda et al., 2018; Reyes & Rosenberg, 2019; Roth & Henley, 2014). A cross-sectional study of maternal health care providers found that provider attitude was significantly associated with their low-risk cesarean delivery rate (White Vangompel et al., 2018). The exact magnitude of the influence of provider attitudes and preferences requires additional research.

Conclusion

The rate of low-risk cesarean deliveries has increased substantially over the last several decades, however there is a lack of evidence to suggest that the current rate provides additional benefits to mothers and infants. In fact, evidence suggests that the overutilization of cesarean delivery without medical indication can increase the risk of maternal morbidity and mortality, as well as infant morbidity (Oakes et al., 2019; Sandall et al., 2018). As such, addressing the rates of NTSV cesarean deliveries is an upstream approach to improving the health of mothers, infants, and families across the U.S. A conceptual framework for understanding of the influences on cesarean delivery rates is needed to evaluate, and later address, variations in NTSV cesarean deliveries. This study conceptualizes the utilization of cesarean sections using the Andersen Healthcare Utilization Model. This serves as framework for covariate selection to address the aims of this dissertation.

Project Aims

The overarching research question this dissertation seeks to answer is "How does the rate of NTSV and elective cesarean deliveries vary across the United States over time?". In order to answer this question, two primary project aims have been developed. The first project aim is to examine the variation in NTSV and elective cesarean deliveries in the United States from 2016 to 2020. The second project aim is to then examine the extent to which the variation in NTSV and elective cesarean delivery rates nationally is mirrored in the Appalachian sub-regions. Based on the examination of the existing body of scholarly literature, it is hypothesized that the rates of NTSV and elective cesarean deliveries will be higher among more affluent communities compared to lower resource communities. Similarly, it is hypothesized that the rates of NTSV and elective cesarean deliveries will be lower in Appalachia relative to national averages. Lastly, based on the evidence of the impact of healthcare resources, socioeconomic status, and geography on low-risk cesarean deliveries, it is also hypothesized that the rates of NTSV and elective cesarean deliveries will be lowest in Central Appalachia and highest in Northern Appalachia.

Chapter 3. Methodology

Aim 1

The first aim of this dissertation is to examine the variation of NTSV and elective cesarean deliveries across the United States between 2016 and 2020. The proposed study will add to the existing body of scholarly literature by providing an updated longitudinal analysis of cesarean deliveries in the U.S. Longitudinal studies on the changes in cesarean delivery rates in the U.S. encompass time periods including 1970-1978 (Hoxha, Syrogiannouli, Braha, et al., 2017; Roth & Henley, 2014; Sakai-Bizmark et al., 2021), 1979-2004 (Joesch et al., 2008), 1979-2010 (Ananth et al., 2017), 1988-1993 (Clarke & Tafil, 1995), 1990-2013 (Osterman & Martin, 2014b), 1990-2014 (Weimer et al., 2019), 1996-2011 (Osterman & Martin, 2013), 2006-2012 (Osterman & Martin, 2014), 2005-2014 (Hehir et al., 2018), and 2010-2014 (Rosenbloom et al., 2017). However, there is a lack of evidence about the longitudinal changes in cesarean delivery rates after 2014. Predominantly more recent estimations and examinations of changes in the low-risk cesarean delivery rate are cross-sectional and/or represent changes within single institutions or health systems. As such this project seeks to help fill this gap in knowledge. The secondary purpose of this aim is to estimate longitudinal changes in elective cesarean deliveries among low-risk women. There is substantial debate as to the prevalence of elective cesarean deliveries, or cesarean deliveries on maternal request, in the U.S. (Yamamoto, 2011). Current estimations on the prevalence of elective cesarean deliveries from the American College of Obstetrics and Gynecology suggest that about 2.5% of births are cesarean section on maternal request ("ACOG Committee Opinion No. 761: Cesarean Delivery on Maternal Request," 2019). However, other research suggests that the rate of cesarean deliveries on maternal request are even greater from 5% to 11.2% ("ACOG Committee Opinion No. 761: Cesarean Delivery on Maternal Request," 2019; Gossman et al., 2006). Currently, few studies have examined the rate of cesarean delivery on maternal request over time in the U.S. (Gossman et al., 2006) and to the author's knowledge none have examined changes in recent years. This dissertation will provide more recent and longitudinal estimates of elective cesarean deliveries, as well as identify areas in which greater volumes of elective cesarean deliveries area occurring, which may indicate a need for intervention at the policy level. A third purpose of this aim is to establish a reference value against which to measure the change in NTSV cesarean delivery rates at the national level compared to distinct sub-regions of the U.S., which will be important for Aim 2.

It is hypothesized that the rates of NTSV and elective cesarean deliveries will be higher among more women who live in more affluent, high-resource communities compared to low-resource communities. This hypothesis is based on the existing body of scholarly literature which suggests that rural, low-resource hospitals have lower rates of low-risk and non-medically indicated cesarean deliveries compared to urban hospitals (Kozhimannil, Hung, et al., 2014b). This is, in part, contributed to the fact that urban hospital hospitals, who see a high patient volume, are more likely to see patients with higher obstetric risk (Janakiraman et al., 2011). Additionally, in examinations of cesarean delivery rates in other developed nations have found that women who reside in affluent communities are more likely to deliver via non-medically indicated cesarean section compared to women from less affluent communities (Alves & Sheikh, 2005). Similarly, research indicates that high-income women are more likely to have a cesarean section without medical indication compared to lower-income women (Coonrod et al., 2008; Gould et al., 1989; Roth & Henley, 2014).

Study Design and Data Sources

A retrospective repeated cross-sectional analysis of NTSV and elective cesarean delivery rates between 2016 and 2020 will be conducted using individual-level vital records data. Primarily, data will be collected from birth certificate records from the National Center for Health Statistics (NCHS) National Vital Statistics System (NVSS). This study will include data for NTSV births between the years of 2016 and 2020. Data will also be collected from the Area Health Resource File (AHRF) and the Appalachian Regional Commission (ARC).

Outcome Measures and Covariates of Interest

The primary outcome of interest will be rate of low-risk cesarean deliveries. Consistent with previous literature (Kozhimannil, Law, et al., 2013; Martin et al., 2019, 2021), low-risk cesarean delivery rate is defined as the percent of the total number of nulliparous, term, singleton, vertex (NTSV) births that are cesarean deliveries with no medical indicators of need. Given this study is interested in the changes in NTSV cesarean deliveries, time is also a primary independent variable. Time will be indicated by the birth year recorded on the birth certificate.

The secondary outcome of interest will be the rate of elective cesarean deliveries. The rate of elective cesarean deliveries can used to approximate the rate of cesarean deliveries on maternal request, one of the most commonly cited reasons for the increased rates of low-risk cesarean deliveries in the U.S. (Viswanathan et al., 2006; Yamamoto, 2011). Consistent with previous literature, the rate of elective cesarean deliveries will be calculated as the percent of all live NTSV births which are cesarean deliveries with no indication of a trial of labor and no indications of medical need (D'Souza & Arulkumaran, 2013; Gossman et al., 2006). The current revision of the birth certificate utilized across the U.S. asks the question "If cesarean, was trial of labor attempted?" if that question is marked "No" then it can be presumed that the procedure was planned. In order to fully understand those factors which, contribute to the variation in NTSV and elective cesarean deliveries the Andersen Healthcare Utilization Model will be utilized for covariate selection and organization. As the proposed study is focused on variation in NTSV and elective cesarean deliveries, variable selection will focus on the individual, health systems, and the broader community levels.

Environmental Characteristics. Environmental factors, specifically rurality and healthcare resource density, play a major role in the variation of low-risk cesarean deliveries. Consistent with previous literature on women's and maternal health outcomes (Hillemeier et al., 2004; Kozhimannil et al., 2018; Orimaye et al., 2021), and in order to account for the impact of geography, the 2013 Urban Influence Codes (UIC) classifications from the Federal Office of Management and Budget (OMB) will be included. The UIC classification categorizes counties, as well as county equivalents and independent cities, into 12 subgroups, two metro and 10 nonmetro (Parker, 2013). The UIC codes will be organized into a four-level variable which will include metropolitan, micropolitan, non-core adjacent, and non-core nonadjacent. Counties are designated as adjacent is at least 2% of the employed residents of that county travel to neighboring metropolitan or micropolitan areas for work (Parker, 2013). The utilization of the multi-level categorical variable for geography will allow the analysis to account for variations in resource density that may be available in areas adjacent to metropolitan or micropolitan areas compared to those that are more rural. UIC codes will be assigned by Federal Information Processing System (FIPS) codes of the mother's county of residence. Metropolitan counties will serve as the reference group in the analyses.

The Health Professional Shortage Area (HPSA) designations, specifically geographic HPSA, from the AHRF will be utilized to estimate healthcare resource density and access to health services (U.S. Department of Health and Human Administration, 2019). These HPSA codes estimate shortages based on the availability of health care providers for a geographic area, in this case at the county level. HPSA classifications include whole shortage, parts shortage, or none designation. None designation refers to counties which have all three types of providers within the county and will be coded as 0. Counties which lack all types of providers are categorized as whole shortage counties and coded as 1. In counties which have a portion of the three types of providers the county is classified as parts shortage and coded as 2 (U.S. Department of Health and Human Administration, 2019). As with the UIC codes, HPSA designations will be assigned by FIPS codes of the mother's county of residence.

Predisposing Characteristics. Predisposing characteristics which will be included in this analysis are individual-level demographics and all have been shown to be significantly associated with variations in cesarean delivery rates in the current body of scholarly research. Demographic characteristics which will be included in the analysis are age (15-19, 20-34, 35 years and older), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other), educational attainment (less than high school, high school diploma or equivalent, some college or Associates degree, and advanced degrees), body mass index (BMI) (underweight or ≤18.5 kg/m^2, normal weight or 18.5-24.9 kg/m^2, overweight or 25.0-29.9 kg/m^2, obese or 30.0-39.9 kg/m^2, extremely obese or ≥40.0 kg/m^2), and timing of prenatal care (first trimester, second trimester, third trimester, or no prenatal care). Health systems level predisposing characteristics are provider type and availability, which has already been accounted for through the inclusion of the HPSA classifications from the AHRF.

Enabling Characteristics. Enabling characteristics refers to factors which "facilitate or impede the use of health services" (Andersen, 1995; Andersen et al., 2011; Babitsch et al., 2012). Common examples of enabling characteristics are income, employment status, insurance, and more generally the availability of resources. Data on a mother's income is not gathered on birth records. In order to assess the impact of socioeconomic status and income on NTSV and elective cesarean deliveries, the Appalachian Regional Commission (ARC) economic classification system will be included in the analysis (Meit et al., 2017a). The ARC economic classification system is a composite measure that utilizes three common indicators of socio-economic status including three-year average per capita income, unemployment rate, and poverty rate (Meit et al., 2017a). These measures are ordered and ranked into a five-level categorical variable which designate counties as attainment, competitive, transitional, at-risk, and distressed. Attainment and competitive classifications represent the top 25% of all counties in the U.S., whereas the at-risk and distressed classifications represent the bottom 25% of all counties (Meit et al., 2017a). ARC economic classification will be assigned by FIPS codes of the mother's county of residence. Additionally, insurance coverage will be included as it has been shown to be significantly associated with variations in NTSV and elective cesarean deliveries, however the evidence has been mixed (Hoxha, Syrogiannouli, Braha, et al., 2017, 2017). To assess the insurance coverage of the sample population, the mother's payment source will be collected from the birth records data. The types of payment source included will be private insurance, Medicaid, self-pay, and other. Information on employment status is not available within the birth records data and will not be included in the analyses. A third enabling characteristic which will be included in the analyses is the time of the day and the day of the week in which a woman gave birth. Research indicates that the time of day a woman is laboring is significantly associated with her risk of delivering via cesarean section (Bailit, 2012; Brown, 1996; Burns et al., 1995; Haberman et al., 2013; Roth & Henley, 2014; Son et al., 2020). Consistent with previous studies (Haberman et al., 2013), time of delivery will be divided into a six-level categorical variable 12 a.m. to 4 a.m. (0:00-4:00), 4 a.m. to 8 a.m. (4:00-8:00), 8 a.m. to 12 p.m. (8:00-12:00), 12 p.m. to 4 p.m. (12:00-16:00), 4 p.m. to 8 p.m. (16:00-20:00), and 8 p.m. to 12 a.m. (20:00-24:00). Additionally, the day of delivery will be included in this analysis because research indicates that the variations in cesarean deliveries depending on if labor occurs during a weekday or on the weekend (Haberman et al., 2013). Births Monday through Friday will be categorized as weekday (0) and births on Saturday and Sunday will be categorized as weekend (1).

Need Characteristics. In Andersen's Healthcare Utilization Model, need characteristics encompass a patient's perceived needs as well as a provider's evaluation of need for healthcare services (Andersen, 1995; Andersen et al., 2011; Babitsch et al., 2012). In order to account for evaluated need for cesarean delivery, common risk factors for cesarean delivery which would factor into a provider's assessment of need will be collected from the individual NVSS birth certificate records. Common risk factors collected from birth certificate records will include smoking during pregnancy, gestational diabetes, hypertension, and sexually transmitted infections (STIs). These variables will all be dichotomized as "Yes" (1) if the risk factor is present or "No" (0) if the risk factor is not present.

Inclusion and Exclusion Criteria

Inclusion criteria for this analysis is women of reproductive age who at the time of delivery were 1) nulliparous, or first-time, mothers, 2) pregnant with a single infant, 3) at term, defined as 37 weeks gestation or greater, and 4) presenting in the vertex or head down position. Exclusion criteria will include the following: 1) gestation of less than 37 weeks, 2) multiparous, 3) multiple gestation, 4) fetal malpresentation. Women under the age of 15 and over 45 years of age will not be included in this analysis because as reproductive age will be defined by ACOG guidelines which defines reproductive age as 15-44 years. Women whose estimated gestation is post-term, defined by ACOG and SMFM as greater than or equal to 42 weeks, because that is a widely accepted indication of need for medical intervention, such as induction of labor and cesarean delivery. Records without data on the method of delivery will not be included.

Analytic Approach

Descriptive analysis examining the characteristics of low-risk NTSV mothers by Urban Influence Codes and covariates of interest will be conducted. Frequencies and 95% confidence intervals will be calculated. One-way analysis of variance (ANOVA) and Chi-square tests will be utilized to identify if there are significant differences in the covariates of interest by geography and birth year. Bivariate differences in the rate of NTSV cesarean deliveries between 2016 and 2020 will be examined at the national level using an unadjusted regression model.

Logistic regression modeling will be utilized for the adjusted analysis of the trends in NTSV cesarean deliveries due to the nature of the outcome variable, i.e., dichotomized categorical variable. Additionally, a marginal analysis of the logistic regression models will estimate the predicted average prevalence of NTSV cesarean deliveries for each UIC classification while controlling for individual-level sociodemographic characteristics and risk factors. Descriptive, bivariate, and multivariate analyses will be repeated with elective cesarean deliveries as the primary outcome to determine the variation in these deliveries across the U.S. during the study period. All analyses will be conducted using Stata 15 software (StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC.).

In compliance with federal and institutional policy, a Form 129 was filed with the East Tennessee State University Institutional Review Board. Due to the nature of birth records data from the NCHS NVSS and other proposed data sources, i.e., publicly available and de-identified, this analysis was deemed to be non-human subjects research and therefore exempt by the ETSU IRB.

Aim 2

The second aim of this dissertation is to examine the extent to which the variation in NTSV and elective cesarean deliveries in the U.S. is mirrored in the Appalachian sub-regions between 2016 and 2020. This analysis will add to the existing body of literature by examining the changes in NTSV and elective cesarean deliveries within this culturally distinct subregion of the U.S. The Appalachian region is a predominantly rural region that spans across 205,000 square miles running from Mississippi to New York, and is comprised of 420 individual counties (Marshall et al., 2017). The region is subdivided into five sub-regions of similar geography and topography including Southern, South Central, Central, North Central, and Northern (Marshall et al., 2017). While a broad number of studies on various perinatal and broader health outcomes have been conducted in Appalachia (Meit et al., 2017a; G. K. Singh et al., 2017; G. K. Singh & Siahpush, 2014), to the author's knowledge this will be the first study to examine these issues longitudinally in Appalachia. Health disparities are well documented in Appalachia attributed, in part, to geographic isolation, persistent poverty, poor economic mobility (Marshall et al., 2017; G. K. Singh et al., 2017). Further, access to health care providers and health care services are very limited compared to what is seen nationally (Marshall et al., 2017; G. K. Singh et al., 2017).

It is generally accepted that in rural areas, where lack of access to health care is prevalent, that populations experience poorer health outcomes. However, in examining low-risk NTSV cesarean deliveries, rural areas have lower rates of low-risk and non-medically indicated cesarean deliveries compared to urban areas (Kozhimannil, Hung, et al., 2014b). Further, compared to high-volume urban hospitals, hospitals in rural communities, who see a lower volume of patients, have lower rates of cesarean deliveries (Clapp et al., 2018). This in part can be attributed to the fact that physicians who see lower numbers of obstetrical patients are more likely to deliver via cesarean compared to physicians who see higher volumes of patients (Clapp et al., 2014; McClelland et al., 2017). As such, it is hypothesized that the rates of NTSV and elective cesarean deliveries will be lower in the Appalachian sub-regions relative to non-Appalachia.

While the sub-regions of Appalachia share similar topographies, the characteristics of populations and the availability and density of health care resources vary substantially (Hale et al., 2022). A recent examination of the characteristics of the sub-regions of Appalachia noted that Northern Appalachia, which is composed of portions of Maryland, New York, Ohio, and Pennsylvania, has a lower proportion whole shortage HPSA designated counties and lower rates of uninsurance among residents under 65 years of age compared to the other Appalachian sub-regions and non-Appalachia (Hale et al., 2022). Further, the Northern Appalachian sub-region has a lower proportion of counties designated at-risk or distressed by the ARC economic classification system compared to other regions (Hale et al., 2022). Conversely, Central Appalachia which is comprised of portions of Kentucky, Tennessee, Virginia, and West Virginia, faces substantial disparities relative to the other sub-regions of Appalachia and non-Appalachia. Socioeconomically, approximately 65% of counties in Central Appalachia are designated as distressed (Hale et al., 2022). Additionally, Central Appalachia has the highest proportion of whole shortage HPSA designated counties, and the second highest proportion of adults without insurance of the Appalachian sub-regions (Hale et al., 2022). Due to the understanding of the differences in the characteristics of the Appalachian sub-regions and the influence of socioeconomic status on the variations in cesarean sections, the secondary hypothesis of this aim is that the rates of NTSV and elective cesarean deliveries will be highest in Northern Appalachia and lowest in Central Appalachia relative to the other Appalachian sub-regions and non-Appalachia.

Study Design and Data Sources

In order to determine if the variation in NTSV and elective cesarean deliveries in Appalachia mirrors national variation, a retrospective repeated cross-sectional study of NTSV births in the U.S. from 2016 to 2020 will be conducted. As with Aim 1, data will be primarily collected from the NCHS birth certificate vital records, as well as the AHRF and the ARC. Inclusion and exclusion criteria are consistent with Aim 1.

Outcome Measures and Covariates of Interest

There are three independent variables in this analysis, NTSV cesarean delivery rate, the elective cesarean delivery rate, and time. Selection of covariates of interest for this analysis was also guided by the Andersen Healthcare Utilization Model. Two environmental characteristics will be included Appalachian designation and HPSA designation. The Appalachian designation will be utilized to account for the impact of geography on the rates of NTSV cesarean deliveries. The Appalachian designation variable will be a six-level categorical variable. Counties will be categorized based on the definitions of the sub-regions from the ARC, where the 420 Appalachian counties will be categorized as Southern, South Central, Central, North Central, and

Northern. The remaining 2,723 counties will be classified as non-Appalachia. Non-Appalachian counties will serve as the reference value for the analyses. HPSA classifications will again to be used to assess and account for access to health care providers and services. Predisposing characteristics for this analysis will be demographic characteristics which will be collected from the birth certificate records. Demographic variables included in the analysis include age, race/ethnicity, BMI, educational attainment, and timing of prenatal care. The ARC economic classification system will be again utilized to account for the influence of socio-economic factors on variations in NTSV and elective cesarean deliveries. Further, insurance coverage will be included as a predisposing factor and will be approximated by the type of payment source used for labor and delivery. Timing of delivery including day of the week and time of delivery will also be included. As with the analysis in Aim 1, the need characteristics which will be included in this analysis are rates of common medical indications of need (gestational diabetes, hypertension, smoking, and STIs).

Analytic Approach

Chi-square and ANOVA testing will be utilized to examine differences in the characteristics of the Appalachian sub-regions relative to non-Appalachia by the covariates of interest. Consistent with extant literature (Hale et al., 2022), bivariate analyses will examine the prevalence of NTSV cesarean delivery rates between 2016 and 2020 using unadjusted logistic regression modeling and predicted means. Multi-variable analysis of the likelihood of NTSV cesarean deliveries will be conducted through logistic regression modeling. Covariates of interest based on the current body of scholarly literature will be included in the adjusted model. A marginal analysis of this model will estimate the predicted average values and 95% confidence intervals of NTSV cesarean deliveries between 2016 and 2020 for each Appalachian sub-region relative to non-Appalachia while controlling for individual-level sociodemographic characteristics and risk factors. Additionally, all analyses will be repeated with elective cesarean delivery rate as the primary outcome to examine the extent to which variation in cesarean delivery on maternal request is equitable across non-Appalachia and the Appalachia sub-regions. Analyses will be conducted using Stata 15 software (StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC.).

Sensitivity Analyses

In addition to the analyses for Aims 1 and 2, one sensitivity analysis of low-risk and elective NTSV cesarean deliveries as the outcome will be performed. In this analysis and in line with current literature (Andrikopoulou et al., 2021), births with reported congenital abnormalities will be excluded to determine if these births are inflating the risk of cesarean delivery and potentially skewing estimations of NTSV and elective cesarean delivery rates.

Anticipated Challenges

The proposed analysis has several anticipated challenges and potential limitations. Though the low-risk grouping of nulliparous, term, singleton, vertex (NTSV) is a common subset of analysis of cesarean delivery variation, the definition is not without criticism. Critics note that this definition of low-risk does not account for common indications of need and medical risk factors (Coonrod et al., 2008; Parrish et al., 1994). In order to address this issue, I will include common medical indications of need for cesarean deliveries from individual birth certificate records. It should be noted that an additional challenge with calculating prevalence of medical risk factors is that there is often a risk for underreporting of these diagnoses or behaviors on the birth certificate records (Roth & Henley, 2014).

Another anticipated challenge is approximating elective cesarean deliveries. Trial of labor is measured on the current birth certificate, however, it may not be clearly indicated or reliably reported across all states (Yamamoto, 2011). Despite the potential challenges associated with the use of vital records, evidence suggests these records are the best resource available to assess population-level variations in cesarean delivery rates (Roth & Henley, 2014). A third potential challenge is that because income and employment data is not collected on birth certificates the influence of these characteristics is approximated using county-level variables and applied to individual observations using the mother's FIPS code, as such this could lead to potential ecological fallacy or bias based on misclassification. Ecological fallacy is a type of bias in observational research in which an author attempts to place the relationships seen at the group level to individuals (Freedman, 1999). I will have to be care of this potential bias within my discussion section and not over assert the importance of economic status or health professional shortage designation because I cannot account for the individual level variation. I will also ensure that it is a clearly stated limitation and has potentially skewed my results in one way or another.

Integration of Competencies

The proposed analyses will address and integrate foundational and concentration competencies in an effort not only add to the current body of existing literature but also bring to light potential overutilization of cesarean sections. This will allow policy makers and health care systems to revisit current policies and practices and implement new guidelines or amend existing guidelines to reduce overutilization and thus improve health outcomes, improve the quality of care, and reduce health care costs.

Foundational Competencies

Data and Analysis. Explain qualitative, quantitative, mixed methods and policy analysis research and evaluation methods to address health issues at multiple (individual, group, organization, community, and population) levels.

This foundational competency will be integrated in several ways. First, in my methodology I have described the quantitative approach to the evaluation of the variation in low-risk and elective NTSV cesarean delivery rates. Additionally, where previous literature on this subject has examined this issue on the national, state, and health systems levels, I will utilize this analysis to address this issue at the regional level. Second, this competency will also be integrated into my field-based products 2 and 3, a manuscript for academic dissemination and an issue brief for broader dissemination to policy makers and health care systems.

Programs and Policies. Integrate knowledge of cultural values and practices in the design of public health policies and programs.

Based on my examination of the current body of scholarly literature, it is clear that cultural values and practices are important drivers of variation in cesarean deliveries. Cultural values in this proposal refer to the personal values and practices of both patients and providers, as well as the broader social norms which drive the utilization of health services. At the patient level, culture influences women's perceptions of risk and as such dictate which interventions a woman may find "less risky" during pregnancy (Miller & Shriver, 2012). At the health systems level, provider practice culture has also been associated with variations in low-risk cesarean delivery rates (Baicker et al., 2006; Henke et al., 2014).

This competency will be predominantly featured in my discussion section, as potential explanations as to variations in utilization of cesarean deliveries among low-risk women. For example, there is a cultural mistrust of outsiders and health care providers within Appalachia and often medical decisions are made predominantly on the basis of experiential stories from family members and peers (Bachman et al., 2018; Katz et al., 2007). As such, women living in Appalachia counties may be less likely to seek out cesarean deliveries leading to lower rates in Appalachia relative to non-Appalachia. Additionally, knowledge about Appalachian culture will help to specify recommendations to stakeholders and policy makers that will be included in the communication and dissemination plan to help ensure that the information is culturally and linguistically appropriate for broad dissemination. Another important consideration is organizational culture. Organizational culture has been the focus of several interventions to address this issue and as such knowledge of current and previous interventions and provider practice patterns will allow me to further specify recommendations for policy and program reform in my communication and dissemination plan (Chapter 6).

Leadership, Management, and Governance. Communicate public health science to diverse stakeholders, including individuals at all levels of health literacy, for purposes of influencing behaviors and policies.

One of the ten essential public health services, as described by the de Beaumont Foundation and the Public Health National Center for Innovations, is to "communicate effectively to inform and educate" (*10 Essential Public Health Services*, n.d.). As such, this competency will be integrated into my communication and dissemination plan, and field-based products 2 and 3. As will be further described in Chapter 6, the results of these analyses will be communicated to researchers and policy makers through publication in a peer-reviewed academic journal, such as the Journal of Appalachian Health, and via presentations at academic conferences. Additionally, an issue brief will be written for broader distribution to health care systems in hopes of inciting organizational behavior change in the provision of cesarean deliveries to women with low-risk labors. The issue brief will emphasize how addressing the issue of overutilization of cesarean deliveries impacts the Triple Aim, as described by Donald Berwick (Berwick et al., 2008), and the impact of ignoring this issue from an accreditation and reimbursement perspective.

Leadership, Management, and Governance. Propose strategies for health improvement and elimination of health inequities by organizing stakeholders, including researchers, practitioners, community leaders, and other partners.

The proposal of strategies for health improvement and elimination of health inequities around the issue of low-risk and elective cesarean deliveries will be integrated into Chapter 5 (Discussion), Chapter 6 (Communication and Dissemination Plan), and field-based products 2 and 3. These proposals will be guided by my review of the current body of scholarly literature and the results of the proposed analyses. Data from quantitative studies will be used to integrate information on variations in cesarean deliveries from other researchers. Data from qualitative literature will be utilized to organize the perceptions and practices of healthcare providers, as well as the knowledge, attitudes, and beliefs around cesarean sections from women of reproductive age into the development of proposed strategies. Additionally, the current literature on interventions to reduce NTSV and elective cesarean deliveries, such as those described in the Cochrane Review conducted by Chen et al. (Chen et al., 2018), will allow me to specify evidence-based interventions that have been shown to reduce the rate of low-risk cesarean deliveries to pertinent stakeholders.

Education and Workforce Development. Deliver training or educational experiences that promote learning in academic, organizational and community settings.

The foundational competency under the content area of “Education and Workforce Development” as described above will be integrated into my communication and dissemination plan. In addition to the publication of a peer-reviewed manuscript and issue brief on the findings of the proposed analysis, I also propose to present these findings to academic peers at conferences, such as American Public Health Association annual conference or the Society for Family Planning annual conference. Both conferences have specific sections dedicated to maternal and child health research. Further, I will reach out to community partners and stakeholders, such as Ballad Health and their accountable care community (ACC) Striving Towards Resilience & Opportunity for the Next Generation (STRONG), to share my issue brief and offer to present the findings of this study and proposed strategies to their organization.

Concentration Competencies: Health Services Management and Policy

> *Integrate individual health information, population health measures and community resources to redesign health service delivery and improve population health.*

To integrate this competency, in the analysis, as described above, I propose the inclusion of population health measures and measures of community resources to account for their influence on variations in low-risk cesarean deliveries in the U.S. and Appalachia. Further, based on the results of the analysis, I will identify which population health and community resource variables are most influential on the low-risk and elective cesarean delivery rates. I will use these factors in the development of proposed strategies to improve the provision of cesarean sections and reduce the overutilization of cesarean sections among low-risk pregnancies. As such, this competency will also be integrated into my discussion in Chapter 5.

Assess the effectiveness of public health and healthcare services aimed at improving population health using applied research methods.

The competency of analyzing the effectiveness of public health and healthcare services will be integrated in Chapter 1 and Chapter 5. Assessing the effectiveness of current interventions to reduce low-risk cesarean sections was utilized, in part, to illustrate how amenable this issue is to change. This information will also be integrated into Chapter 5's discussion as potential influential factors which may be in part responsible for variation in low-risk and elective cesarean deliveries. It is also an important limitation to note, that the proposed analysis will not measure the impact of proposed guideline revisions or current interventions at the health system level.

Analyze patterns of health services utilization, costs, and outcomes and health system performance using applied research methods.

This competency has been integrated in my examination of the current body of scholarly literature in Chapter 2 where I examined peer-reviewed literature to define existing patterns of utilization by geography and health systems characteristics. This assessment informed the development of my research aims and corresponding hypotheses. Further, as my proposed aims focus specifically on the utilization of low-risk cesarean deliveries this competency will also be integrated in my proposed analysis and subsequent results. The integration of this competency will allow me to address gaps in the scholarly literature by providing more recent estimations in the changes in low-risk and elective cesarean section utilization among NTSV mothers, as well as provide evidence, or lack thereof, of potential regional variations in rates between Appalachia and non-Appalachia, a topic which to my knowledge has not yet been examined.

Chapter 4. Results

Study Purpose and Aims

The overarching research purpose of this study is to examine the extent to which the rate of nulliparous, term, singleton, vertex (NTSV) and elective cesarean deliveries vary across distinct geographic sub-groups within the United States (U.S.) over time. As such, two primary project aims have been developed. The first aim is to examine the variation in NTSV and elective cesarean deliveries in the U.S by level of rurality from 2016 to 2020. The second project aim is to then examine the extent to which the variation in NTSV and elective cesarean delivery rates nationally is mirrored in the Appalachian sub-regions.

Study Population and Data Sources

Data was collected from the National Center for Health Statistics (NCHS) National Vital Statistics System (NVSS). The study population consisted of birth records from all 50 states and the District of Columbia for the years 2016 to 2020. As noted in Figure 1, there was a total of 18,907,691 individual birth records in the United States (U.S.) from the years 2016 to 2020. Approximately, 14,261,348 records were excluded for not being low risk. Additionally, another 11,117 records were excluded as these women fell outside of the American College of Obstetrics and Gynecology's definition of reproductive age (15-44 years). Approximately 3,908 records were excluded as they lacked information on the final route of delivery. As such, the total sample size for the examination of variations in NTSV cesarean deliveries is 4,631,318 births. Elective cesarean deliveries are defined as NTSV cesarean deliveries in which no trial of labor was reported. In order to explore the variations in elective cesarean deliveries nationally and within Appalachia, the 4,631,318 records from the analysis of the trends NTSV births were subset to focus on solely on women who had NTSV cesareans. The total number of observations which low-risk women reported having a cesarean delivery, and as such were included in the analysis of elective cesarean deliveries, were 1,138,743 records.

Maternal characteristics of the sample of NTSV births, and subsequently the sample of NTSV births which were cesarean deliveries, are shown in Table 1. While predominantly similar, the two study populations have slight differences in the distribution of characteristics. Relative to all women with NTSV births, higher proportions of women of advanced maternal age, women who have some college credit/Associate's degree, women with advanced degrees, women with obesity and extreme obesity, women with private insurance, and higher proportions of women with gestational diabetes and hypertension had an elective cesarean delivery.

Figure 1

Birth Records Included for Primary Analysis of Trends in NTSV & Elective Cesarean Delivery Rates in the U.S. from 2016-2020

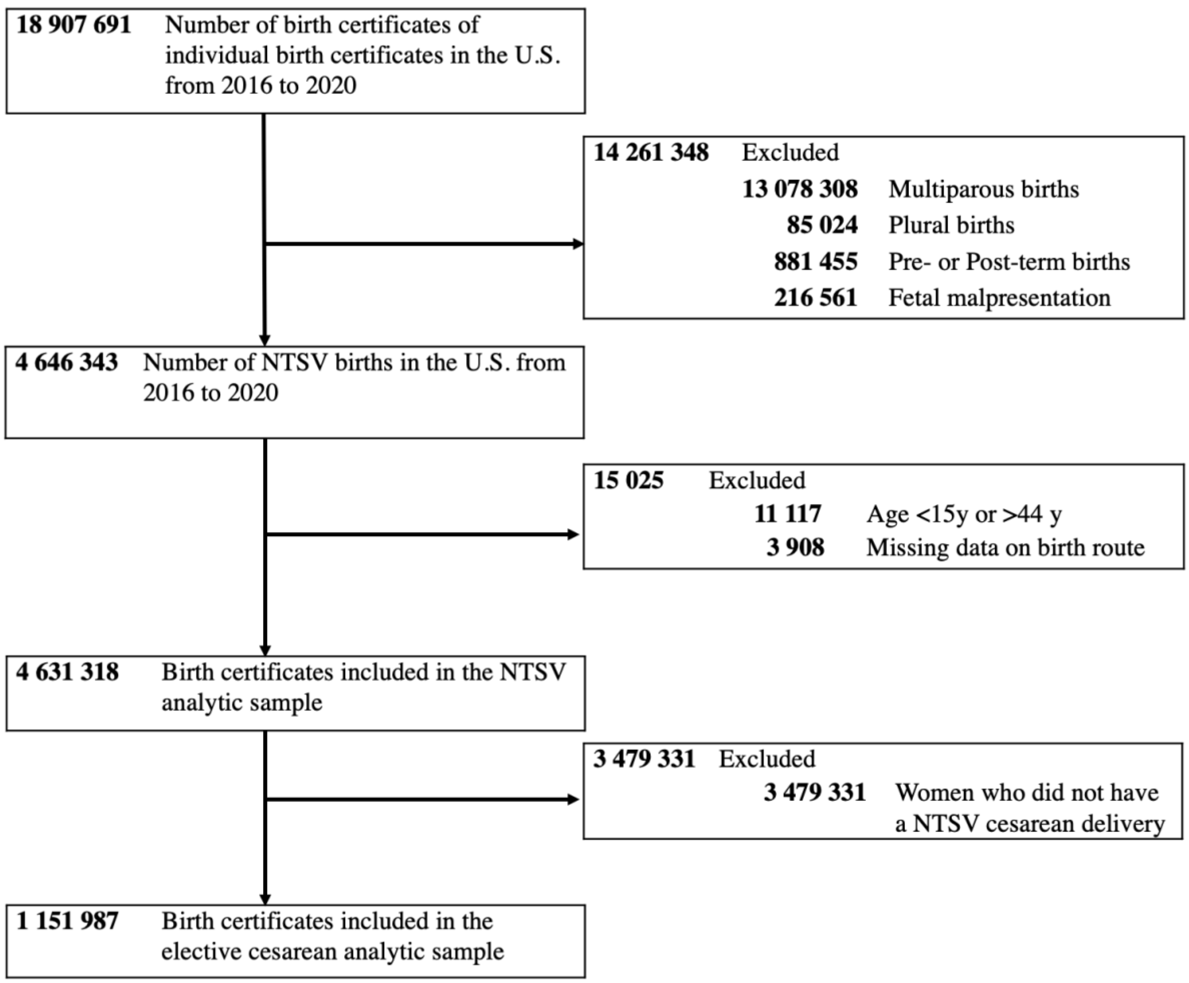

Table 1

Maternal Characteristics Among Low-Risk Pregnancies in the U.S. between 2016-2020 (Mean, 95% C.I.)

Covariate of Interest	NTSV Women (N=4,631,318)	NTSV Women Who Had a Cesarean Delivery (N=1,138,743)
Environmental Characteristics		
Urban Influence Codes		
Metropolitan	87.55 (87.52, 87.58)	87.71 (87.65, 87.77)
Micropolitan	7.61 (7.58, 7.63)	7.42 (7.37, 7.47)
Non-Core Adjacent	4.14 (4.12, 4.16)	4.17 (4.14, 4.21)
Non-Core Non-adjacent	0.70 (0.70, 0.71)	0.69 (0.68, 0.71)
Appalachian Designation		
Non-Appalachia	92.86 (92.84, 92.89)	92.62 (92.57, 92.67)
Southern Appalachia	2.55 (2.54, 2.57)	2.70 (2.67, 2.73)
South Central Appalachia	1.34 (1.33, 1.35)	1.30 (1.28, 1.32)
Central Appalachia	0.52 (0.51, 0.52)	0.56 (0.55, 0.58)
North Central Appalachia	0.64 (0.63, 0.65)	0.66 (0.64, 0.67)
Northern Appalachia	2.09 (2.08, 2.10)	2.16 (2.14, 2.19)
Health Professional Shortage Area Designations		
None Designation	7.32 (7.30, 7.35)	7.35 (7.30, 7.40)
Parts Designation	88.41 (88.38, 88.44)	88.36 (88.30, 88.42)
Whole Designation	4.27 (4.25, 4.29)	4.29 (4.25, 4.33)

Predisposing Characteristics		
Maternal Age		
19 Years & Younger	11.84 (11.81, 11.87)	7.64 (7.59, 7.69)
20-34 Years	79.43 (79.40, 79.47)	78.56 (78.48, 78.63)
35 Years & Older	8.73 (8.70, 8.76)	13.80 (13.74, 13.86)
Maternal Race/Ethnicity		
Non-Hispanic White	53.90 (53.85, 53.94)	51.99 (51.90, 52.08)
Non-Hispanic Black	12.50 (12.47, 12.53)	14.72 (14.66, 14.79)
Hispanic	22.38 (22.34, 22.41)	21.75 (21.67, 21.82)
Non-Hispanic Other	11.23 (11.20, 11.26)	11.54 (11.48, 11.60)
Maternal Educational Attainment		
Less than a High School Diploma	9.95 (9.92, 9.97)	7.88 (7.83, 7.93)
High School Diploma or Equivalent	24.28 (24.24, 24.32)	23.29 (23.21, 23.37)
Some College or Associate's Degree	26.93 (26.89, 26.97)	28.26 (28.18, 28.34)
Advanced Degrees	38.85 (38.80, 38.89)	40.57 (40.48, 40.67)
Maternal Weight^{+}		
Underweight	4.12 (4.10, 4.14)	2.45 (2.42, 2.48)
Normal Weight	48.06 (48.01, 48.10)	37.37 (37.28, 37.46)
Overweight	25.11 (25.07, 25.15)	26.50 (26.42, 26.59)
Obese	18.58 (18.54, 18.61)	25.64 (25.56, 25.72)
Extremely Obese	4.14 (4.12, 4.16)	8.03 (7.98, 8.08)
Trimester Prenatal Care Began		

First Trimester	79.28 (79.24, 79.32)	80.53 (80.45, 80.60)
Second Trimester	14.95 (14.92, 14.99)	14.21 (14.14, 14.27)
Third Trimester	4.47 (4.45, 4.49)	4.16 (4.12, 4.20)
No Prenatal Care	1.30 (1.29, 1.31)	1.10 (1.08, 1.12)
Enabling Characteristics		
ARC Economic Classification++		
Attainment	16.39 (16.36, 16.43)	16.36 (16.29, 16.43)
Competitive	18.81 (18.78, 18.85)	18.25 (18.18, 18.32)
Transitional	56.16 (56.12, 56.21)	56.29 (56.20, 56.38)
At-risk	5.63 (5.61, 5.65)	5.87 (5.83, 5.91)
Distressed	3.00 (2.98, 3.01)	3.23 (3.20, 3.27)
Payment Method		
Private Insurance	56.41 (56.37, 56.46)	59.02 (58.93, 59.11)
Medicaid	36.27 (36.23, 36.32)	34.93 (34.84, 35.02)
Self-Pay	3.45 (3.44, 3.47)	2.69 (2.67, 2.72)
Other	3.86 (3.84, 3.88)	3.36 (3.32, 3.39)
Day of Birth+++		
Weekday	76.48 (76.44, 76.51)	79.18 (79.11, 79.26)
Weekend	23.52 (23.49, 23.56)	20.82 (20.74, 20.89)
Time of Birth		
0:00-4:00	13.58 (13.55, 13.62)	11.95 (11.89, 12.01)
4:01-8:00	12.69 (12.66, 12.72)	11.48 (11.42, 11.54)
8:01-12:00	16.48 (16.45, 16.52)	18.34 (18.27, 18.41)
12:01-16:00	19.41 (19.37, 19.44)	18.91 (18.84, 18.98)

16:01-20:00	20.27 (20.23, 20.31)	20.57 (20.49, 20.64)
20:01-23:59	17.56 (17.53, 17.60)	18.76 (18.69, 18.83)
Need Characteristics		
Smoking During Pregnancy		
Yes	4.06 (4.04, 4.08)	4.24 (4.21, 4.28)
No	95.94 (95.92, 95.96)	95.76 (95.72, 95.79)
Gestational Diabetes		
Yes	5.36 (5.34, 5.38)	7.61 (7.56, 7.66)
No	94.64 (94.62, 94.66)	92.39 (92.35, 92.44)
Hypertension		
Yes	9.63 (9.60, 9.65)	13.94 (13.87, 14.00)
No	90.37 (90.35, 90.40)	86.06 (86.00, 86.13)
Sexually Transmitted Infections		
Yes	2.84 (2.82, 2.85)	2.54 (2.52, 2.57)
No	97.16 (97.15, 97.18)	97.46 (97.43, 97.48)
Congenital Anomalies		
Yes	0.23 (0.23, 0.24)	0.33 (0.32, 0.34)
No	99.77 (99.76, 99.77)	99.67 (99.66, 99.68)

[+]Maternal weight is identified by reported maternal body mass index (BMI) in kg/m^2. Underweight is defined as <18.5 kg/m^2, Normal weight between 18.5-24.9 kg/m^2, Overweight between 25.0-29.9 kg/m^2, Obese between 35.0-39.9 kg/m^2, and Extremely Obese at ≥40.0 kg/m^2.
[++]The Appalachian Regional Commission Economic Classification system is an index-based classification system that categorizes counties based on their three-year average unemployment rates, poverty rates, and per capita market income. Attainment and competitive classifications represent the most economically stable and account for the top 25% of the counties in the U.S. At-risk and distressed classifications represent the most economically weak counties and account for 25% of all counties in the U.S. (Meit et al., 2017a).
[+++]The day on which a woman gives birth has been implicated as a factor contributing to the variation in cesarean delivery rates. Consistent with previous literature (Haberman et al., 2013), weekdays are defined within the context of the “normal” work week (Monday-Friday) and weekends are Saturdays and Sundays.

Sensitivity Analyses

In line with the current body of literature, a sensitivity analysis of non-anomalous births was proposed. Of the 4,646,343 NTSV births in the U.S. between 2016 and 2020, approximately 0.23% (10,672/4,646,343) reported having a congenital anomaly. As anomalous births were less than 1% of the total sample the removal of these observations from the sample would not significantly change the characteristics of the study population indicating that anomalous births are not skewing the overall rates of NTSV and elective cesarean deliveries. However, these births are an important consideration, and their presence will be included as a dichotomous variable (0: No, 1: Yes) will be accounted for in the adjusted analyses of Aims 1 and 2.

Aim 1

The hypothesis for Aim 1 is that NTSV and elective cesarean deliveries will be higher among urban, high resource women compared to rural, low resource women. Of all the singleton births to NTSV pregnancies in the U.S. between 2016 and 2020, approximately 24.9% of births to low-risk mothers were cesarean deliveries (Table 2). Approximately, 87.6% of births in the sample occurred to women who live in a metropolitan county, 7.61% to women who live in a micropolitan county, 4.14% in a non-core adjacent county, and 0.70% in a non-core non-adjacent or rural county.

Aim 1.1: NTSV Cesarean Delivery Variation by Rurality

Table 2

Frequency of NTSV Cesarean Deliveries by Urban Influence Codes, (N, %)

	NTSV Cesarean Delivery	
Urban Influence Code	**Yes**	**No**
Metropolitan (N=4,054,252; 87.6%)	1,011,119 (24.9%)	3,043,133 (75.1%)
Micropolitan (N=352,227; 7.61%)	85,059 (24.2%)	267,168 (75.9%)
Non-Core Adjacent (N=191,815; 4.14%)	47,871 (25.0%)	143,944 (75.0%)
Non-Core Non-Adjacent (N=32,635; 0.70%)	7,911 (24.3%)	24,714 (75.8%)
Total (N=4,630,919; 100%)	1,151,960 (24.9%)	3,478,959 (75.1%)

The prevalence of NTSV cesarean deliveries and the bivariate association between NTSV cesarean deliveries and geographic designation are shown in Table 3 and Table 4, respectively. Chi-square testing was utilized to determine if there were significant differences in the rates of NTSV cesarean deliveries based on Urban Influence Codes (UIC) classification across the study period. There were no significant differences in the unadjusted prevalence of NTSV cesarean deliveries within each geographic region between 2016 to 2020. The frequency of cesarean deliveries among NTSV births is highest among women from non-core adjacent areas and lowest among women from micropolitan and non-core non-adjacent areas. Of note, while there are small fluctuations in the prevalence of NTSV cesarean deliveries, micropolitan, non-core adjacent, and non-core non-adjacent areas show no net increase or decrease over the study period.

Table 3

Unadjusted Prevalence (%) of NTSV Cesarean Deliveries by UIC Classification

Geography	2016	2017	2018	2019	2020
Metropolitan	24.8	25.1	25.0	24.8	25.1
Micropolitan	24.2	24.2	24.2	23.9	24.2
Non-Core Adjacent	25.0	25.1	25.1	24.5	25.0
Non-Core Non-Adjacent	24.2	24.3	24.3	24.4	24.2

*Chi-square testing; p<0.0001

Significant differences in the unadjusted odds of NTSV cesarean deliveries were noted across the geographic designations, with the exception of non-core adjacent areas (OR=1.00, 95% C.I. 0.99-1.01). Relative to metropolitan areas, which are purposed to have the higher levels of resources including health care providers and services, both births in micropolitan areas (OR=0.96, 95% C.I. 0.95-0.97) and births in non-core non-adjacent areas (OR=0.96, 95% C.I. 0.94-0.99) had an approximately 4% lower odds of reporting a NTSV cesarean delivery. The interaction between geographic designation and year of birth was assessed in the unadjusted analysis of the variations in NTSV cesarean deliveries. This interaction was found to be non-significant and as such this interaction variable was not included in the final adjusted model.

Table 4

Unadjusted Odds of NTSV Cesarean Delivery by UIC Classification

Geography	Odds Ratio	95% Confidence Interval
Metropolitan	Ref	
Micropolitan	0.96	0.95, 0.97
Non-Core Adjacent	1.00	0.99, 1.01
Non-Core Non-Adjacent	0.96	0.94, 0.99

After adjusting for the covariates of interest[1], the prevalence of NTSV cesarean deliveries did not vary significantly across the UIC geographic designations or across the study period (Table 5). Metropolitan areas had the highest adjusted prevalence of NTSV cesarean deliveries at the beginning and end of the study period. Additionally, all UIC classifications saw small net increases in the adjusted prevalence of NTSV cesarean deliveries from 2016 to 2020. Micropolitan areas saw the greatest net increase in NTSV cesarean deliveries over the study period.

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[1] Covariates included in the adjusted analysis are UIC classifications, Appalachian designations, year, health professional shortage area designations, age, race/ethnicity, educational attainment, body mass index, trimester prenatal care began, Appalachian Regional Commission economic classification, day of birth, time of birth, and presence of common medical risk factors and behaviors (smoking during pregnancy, gestational diabetes, hypertension, sexually transmitted infections, and congenital anomalies).

Table 5

Adjusted Prevalence (%) of NTSV Cesarean Deliveries by UIC Classification

Region	2016	2017	2018	2019	2020
Metropolitan	24.9	25.2	25.0	24.8	25.1
Micropolitan	24.2	24.5	24.4	24.2	24.5
Non-Core Adjacent	24.7	25.0	24.8	24.6	24.9
Non-Core Non-Adjacent	24.5	24.7	24.6	24.4	24.7

Aim 1.2: Elective Cesarean Delivery Variation by Rurality

Of the sub-set women who had a NTSV cesarean delivery in the U.S. between 2016 to 2020, approximately 37.2% of those cesarean deliveries did not report a trial of labor, i.e., were elective (Table 6). Approximately, 87.7% of elective births occurred in a metropolitan area, 7.42% in a micropolitan area, 4.17% in a non-core adjacent area, and 0.69% in a non-core non-adjacent area.

Table 6

Frequency of Elective Cesarean Deliveries by Urban Influence Codes (N, %)

	Elective Cesarean Delivery	
Urban Influence Code	**Yes**	**No**
Metropolitan (N=998,815; 87.7%)	390,403 (39.1%)	608,412 (60.9%)
Micropolitan (N=84,518; 7.42%)	20,051 (23.7%)	64,467 (76.3%)
Non-Core Adjacent (N=47,512; 4.17%)	11,996 (25.3%)	35,516 (74.8%)
Non-Core Non-Adjacent (N=7,871; 0.69%)	1,556 (19.8%)	6,315 (80.2%)
Total (N=1,138,716; 100%)	424,006 (37.2%)	714,710 (62.8%)

The unadjusted prevalence of elective cesarean sections and the bivariate association between elective cesarean deliveries and geographic designation are shown in Table 7 and Table 8, respectively. There are significant differences in the unadjusted prevalence of elective cesarean deliveries by UIC from 2016 to 2020, with the exception of non-core non-adjacent areas. Frequency of elective cesarean sections is highest among women from metropolitan areas and lowest among women from non-core non-adjacent areas. Across the study period, decreases in elective cesarean deliveries can be seen across all geographic designations. Metropolitan areas saw the largest unadjusted decrease in elective NTSV cesarean deliveries from 2016 to 2020 and non-core non-adjacent areas had the lowest decrease.

Table 7

Unadjusted Prevalence (%) of Elective Cesarean Deliveries by UIC Classification

Geography	2016	2017	2018	2019	2020
Metropolitan*	42.5	40.5	39.1	36.9	36.1
Micropolitan*	25.1	24.5	24.4	22.5	22.1
Non-Core Adjacent*	27.0	25.5	25.4	24.1	24.0
Non-Core Non-Adjacent	20.0	21.0	19.1	19.4	19.3

*Chi-square testing; p<0.0001

Significant differences in the unadjusted odds of elective cesarean deliveries were noted across the UIC classifications. Relative to women in metropolitan areas, women in all other geographic classifications have significantly lower odds of having an elective cesarean delivery. Women living in non-core non-adjacent have 62% lower odds (OR=0.38, 95% C.I. 0.36-0.41) of having an elective cesarean delivery compared to women in metropolitan areas.

Table 8

Unadjusted Odds of Elective Cesarean Delivery by UIC Classification

Geography	Odds Ratio	95% Confidence Interval
Metropolitan	Ref	
Micropolitan	0.49	0.48, 0.49
Non-Core Adjacent	0.53	0.52, 0.54
Non-Core Non-Adjacent	0.38	0.36, 0.41

After adjusting for covariates of interest, the prevalence of elective cesarean deliveries varied substantially based on geographic designation (Table 9). Consistent with unadjusted analyses, metropolitan areas had the highest prevalence of elective cesarean deliveries and non-core non-adjacent areas had the lowest prevalence. All geographic areas saw decreases in elective cesarean deliveries from 2016 to 2020, with metropolitan areas seeing the largest decline over this period.

Table 9

Adjusted Prevalence (%) of Elective Cesarean Deliveries by UIC Classification

Region	2016	2017	2018	2019	2020
Metropolitan	41.5	39.7	38.6	36.2	35.4
Micropolitan	26.8	26.3	25.4	23.5	23.0
Non-Core Adjacent	28.8	27.3	26.4	24.4	23.8
Non-Core Non-Adjacent	23.7	22.3	21.5	19.8	19.3

Aim 2

Within this aim are two hypotheses. First, it is hypothesized that the rates of NTSV and elective cesarean deliveries will be lower in the Appalachian sub-regions relative to non-Appalachia. Second, that the rates of NTSV and elective cesarean deliveries will be highest in Northern Appalachia and lowest in Central Appalachia relative to the other Appalachian sub-regions.

Aim 2.1: NTSV Cesarean Delivery Variation in Appalachia

Approximately 24.9% of all the births to NTSV pregnancies in the U.S. between 2016 and 2020 were cesarean deliveries (Table 10). The frequency of NTSV cesarean deliveries ranges from 24% in South Central Appalachia to 27.1% in Central Appalachia. The Appalachian region extends over 200,000 miles across 13 states and is made up of five sub-regions, Southern, South Central, Central, North Central, and Northern (*The Appalachian Region - Appalachian Regional Commission*, n.d.). While these sub-regions share similar topographies and demographic characteristics, recent research indicates substantial variation in socioeconomic characteristics, access to health care resources, and health outcomes (Hale et al., 2022; Meit et al., 2017a). Additionally, the distribution of rural and urban counties is not equal across the Appalachian sub-regions. Central Appalachia has substantially more rural counties compared to the other Appalachian sub-regions (Pollard & Jacobsen, 2021). Conversely, Southern Appalachia has markedly more urban counties relative to the other sub-regions (Pollard & Jacobsen, 2021). These factors likely drive the variations in the frequency of NTSV cesarean deliveries and as such were included in the adjusted analysis.

Table 10

Frequency of NTSV Cesarean Deliveries by Appalachian Designation, (N, %)

	NTSV Cesarean Delivery	
Appalachian Designation	**Yes**	**No**
Non-Appalachia (N=4,300,391; 92.9%)	1,067,058 (24.8%)	3,233,333 (72.2%)
Southern Appalachia (N=118,151; 2.55%)	31,327 (26.4%)	86,914 (73.6%)
South Central Appalachia (N=62,046; 1.34%)	14,914 (24.0%)	47,132 (76.0%)
Central Appalachia (N=23,827; 0.51%)	6,445 (27.1%)	17,382 (73.0%)
North Central Appalachia (N=29,717; 0.64%)	7,609 (25.6%)	22,108 (74.4%)
Northern Appalachia (N=96,781; 2.09%)	24,696 (25.5%)	72,085 (74.5%)
Total (N=4,630,919; 100%)	1,151,960 (24.9%)	3,478,959 (75.1%)

The unadjusted prevalence of NTSV cesarean deliveries in Appalachia and non-Appalachia are shown in Table 11. There are no significant differences in the unadjusted prevalence of NTSV cesarean deliveries in the Appalachian sub-regions compared to non-Appalachia or within each region over the study period. Frequency of NTSV cesarean deliveries was higher among the sub-regions of Appalachia at the beginning and end of the study period, with the exception of South Central Appalachia who had the lowest unadjusted prevalence of NTSV cesarean deliveries in 2020. Non-Appalachia, Southern Appalachia, and South Central Appalachia saw net decreases in unadjusted prevalence of NTSV cesarean deliveries through the study period, whereas Central Appalachia, North Central, and Northern Appalachia all saw small increases across the study period.

Table 11

Unadjusted Prevalence (%) of NTSV Cesarean Deliveries by Appalachian Designation

Sub-region	2016	2017	2018	2019	2020
Non-Appalachia	24.7	25.0	24.8	24.6	24.9
Southern Appalachia	26.4	26.4	26.8	26.4	26.2
South Central Appalachia	24.1	24.4	24.6	23.8	23.3
Central Appalachia	26.0	27.6	27.1	27.6	27.1
North Central Appalachia	25.8	25.6	25.2	25.4	26.1
Northern Appalachia	25.0	25.8	25.4	25.7	25.7

*Chi-square testing; p<0.0001

Significant differences in the unadjusted odds of NTSV cesarean deliveries were noted amongst the Appalachian sub-regions relative to non-Appalachia (Table 12). Women within the sub-regions of Appalachia, with the exception of South Central Appalachia, are at an increased odds of having a NTSV cesarean delivery compared to women in non-Appalachia. Central Appalachian women, in particular, are at 12% higher odds of having a low-risk cesarean section compared to non-Appalachian women. Conversely, women in South Central Appalachia were at 4% lower odds of having a NTSV cesarean section compared to women in non-Appalachia. The interaction between Appalachian designation and year of birth was assessed in the unadjusted analysis of the variations in NTSV cesarean deliveries. This interaction was found to be non-significant and as such this interaction variable was not included in the final adjusted model.

Table 12

Unadjusted Odds of NTSV Cesarean Delivery by Appalachian Designation

Sub-region	Odds Ratio	95% Confidence Interval
Non-Appalachia	Ref	
Southern Appalachia	1.09	1.08, 1.10
South Central Appalachia	0.96	0.94, 0.98
Central Appalachia	1.12	1.09, 1.16
North Central Appalachia	1.04	1.02, 1.07
Northern Appalachia	1.04	1.02, 1.05

After adjusting for the covariates of interest, the marginal analysis of the prevalence of NTSV cesarean deliveries varied significantly ($p<0.0001$) based on Appalachian designation and across the study period (Table 13). These findings could be in part due to the substantial sample size and the significant differences in the percent of women who gave birth in non-Appalachia compared to the Appalachian sub-regions. At the beginning of the study period, South Central Appalachia had the lowest adjusted prevalence of NTSV cesarean deliveries and Central

Appalachia had the highest. While an intermediate declines in NTSV cesarean deliveries was noted, all sub-regions of Appalachia and non-Appalachia saw a small net increase in the adjusted prevalence of NTSV cesarean deliveries across the study period. Central Appalachia, in particular, had the highest adjusted prevalence of NTSV cesarean deliveries at the beginning and end of the study period. Conversely, South Central Appalachia had the lowest adjusted prevalence of NTSV cesarean deliveries across the study period.

Table 13

Adjusted Prevalence (%) of NTSV Cesarean Deliveries by Appalachian Designation

Region	2016	2017	2018	2019	2020
Non-Appalachia	24.8	25.0	24.9	24.7	25.0
Southern Appalachia	25.9	26.2	26.0	25.8	26.1
South Central Appalachia	24.3	24.6	24.5	24.3	24.6
Central Appalachia	26.2	26.5	26.4	26.2	26.4
North Central Appalachia	25.4	25.7	25.6	25.4	25.7
Northern Appalachia	25.6	25.9	25.7	25.5	25.8

Aim 2.2: Elective Cesarean Delivery Variation in Appalachia

Table 14 shows the overall frequency of elective cesarean deliveries in non-Appalachia and the Appalachian sub-regions. Of all the NTSV cesarean deliveries in the U.S. between 2016 and 2020, approximately 37% were elective cesarean deliveries. Approximately 92.6% of births in this sample occurred to women in non-Appalachia, 2.70% to women in Southern Appalachia, 1.30% to women in South Central Appalachia, 0.56% to women in Central Appalachia, 0.66% to women in North Central Appalachia, and 2.16% to women in Northern Appalachia. The frequency of elective cesarean deliveries is highest in non-Appalachia, 37.9%, and ranges from 24.2% in North Central Appalachia to 35.9% in Southern Appalachia.

Table 14

Frequency of Elective Cesarean Deliveries by Appalachian Designation, (N, %)

	Elective Cesarean Delivery	
Appalachian Designation	**Yes**	**No**
Non-Appalachia (N=1,054,662; 92.6%)	399,765 (37.9%)	654,897 (62.1%)
Southern Appalachia (N=30,728; 2.70%)	11,033 (35.9%)	19,695 (64.1%)
South Central Appalachia (N=14,795; 1.30%)	3,827 (25.9%)	10,968 (74.1%)
Central Appalachia (N=6,414; 0.56%)	1,575 (24.6%)	4,839 (75.4%)
North Central Appalachia (N=7,475; 0.66%)	1,806 (24.2%)	5,669 (75.8%)
Northern Appalachia (N=24,641; 2.16%)	6,000 (24.4%)	18,641 (75.7%)

Total (N=1,138,715; 100%)	424,006 (37.2%)	714,709 (62.8%)

The prevalence of elective cesarean deliveries and the bivariate association between elective cesarean deliveries and Appalachian designation are shown in Table 15 and Table 16, respectively. Significant differences in the unadjusted odds of elective cesarean deliveries were noted across the Appalachian sub-regions and non-Appalachia. Relative to women in non-Appalachia, women in Appalachia had significantly lower unadjusted rates of elective cesarean deliveries compared to women in non-Appalachia. Southern Appalachia had the highest unadjusted prevalence of elective cesarean sections compared to the other Appalachian sub-regions across the study period. Conversely, Central and North Central Appalachia had the lowest unadjusted rates of elective cesarean deliveries relative to the other sub-regions and non-Appalachia.

Table 15

Unadjusted Prevalence (%) of Elective Cesarean Deliveries by Appalachian Designation

Sub-region	**2016**	**2017**	**2018**	**2019**	**2020**
Non-Appalachia*	41.1	39.3	37.9	35.8	35.1
Southern Appalachia*	38.4	38.4	37.6	34.4	30.6
South Central Appalachia*	29.9	26.8	25.8	23.6	22.9
Central Appalachia*	25.7	25.1	26.9	21.5	23.4
North Central Appalachia*	24.2	24.1	26.4	22.6	23.5

Northern Appalachia*	27.8	23.1	23.8	23.7	23.3

*Chi-square testing; p<0.05

Relative to women in non-Appalachia, women in all of the Appalachian sub-regions were at a significantly lower odds of having an elective cesarean delivery. In particular, women in North Central Appalachia had the highest difference in the unadjusted odds of having an elective cesarean delivery (OR=0.52, 95% C.I. 0.50-0.55) compared to non-Appalachia, whereas Southern Appalachia had the lowest difference in unadjusted odds (OR=0.92, 95% C.I. 0.90-0.94).

Table 16

Unadjusted Odds of Elective Cesarean Delivery by Appalachian Designation

Sub-region	**Odds Ratio**	**95% Confidence Interval**
Non-Appalachia	Ref	
Southern Appalachia	0.92	0.90, 0.94
South Central Appalachia	0.57	0.55, 0.59
Central Appalachia	0.53	0.50, 0.56
North Central Appalachia	0.52	0.50, 0.55
Northern Appalachia	0.53	0.51, 0.54

After adjusting for the covariates of interest, the predicted prevalence of elective cesarean deliveries varied substantially based on Appalachian designation and across the study period (Table 17). The predicted prevalence of elective cesarean deliveries was consistently higher in

Southern Appalachia compared to non-Appalachia and the other Appalachian sub-regions. Northern Appalachia had the lowest predicted prevalence of elective cesarean deliveries compared to non-Appalachia and the other Appalachian sub-regions from 2016 to 2020.

Table 17

Adjusted Prevalence (%) of Elective Cesarean Deliveries by Appalachian Designations

Region	2016	2017	2018	2019	2020
Non-Appalachia	40.3	38.5	37.4	35.0	34.3
Southern Appalachia	41.3	39.5	38.4	36.0	35.3
South Central Appalachia	31.6	30.0	29.1	27.0	26.4
Central Appalachia	32.5	30.8	29.9	27.8	27.1
North Central Appalachia	30.0	28.4	27.5	25.5	24.9
Northern Appalachia	26.7	25.2	24.4	22.5	22.0

Challenges and Solutions

Within the course of these analyses, several primary challenges arose. The first primary challenge was to clearly define and measure if a woman had an elective cesarean delivery. Historically, it has been noted that it is difficult to approximate this issue, and past research has varied definitions making it difficult to compare studies and elucidate patterns (McCourt et al., 2007). In order to address this challenge, the vital records data gathered from the NCHS was limited to 2016 and after. Limiting data collection to 2016 and after ensured that all states and counties are collecting data via the 2003 revision of the birth certificate. The 2003 revision of the birth certificate allows for a clearer approximation of elective cesarean deliveries by collecting data on trial of labor. As aforementioned, a birth record which indicates no trial of labor, meaning at no point was vaginal delivery attempted, is therefore a planned or elective procedure. In addition, a secondary challenge in approximating elective cesarean deliveries, as we have done here, is reliance on a single question to measure elective cesarean deliveries. As noted in the current body of scholarly literature, data collected via providers on the birth certificate can lead to issues with validity, as this data is not always consistently reported (Andrikopoulou et al., 2021; Yamamoto, 2011). To address this issue, observations with missing data on trial of labor were excluded from the analyses.

The second primary challenge in the above analyses was to account for the influence of socioeconomic resources and health care resources on NTSV and elective cesarean deliveries, as data on these characteristics are not collected on birth records. The influence of socioeconomic status was estimated utilizing the ARC economic classification system, and the influence of health care resources was estimated using the Area Health Resource File (AHRF) Health Professional Shortage Area (HPSA) designations. The ARC economic classification system and the HPSA designations is that these metrics are county level measures which were applied to individual level observations, as such potential misclassification bias is introduced into the results of the analyses. Despite the introduction of bias, the importance of socioeconomic and health care resources on variations in cesarean deliveries is well established within the current scholarly literature, as seen in Chapter 2, necessitating its inclusion within the above analyses.

A benefit of utilizing a large and well-established database, such as the NCHS natality files, is that there is a large pool of available observations which are largely representative of the population leading to increased statistical power and higher external validity. However, large samples derived from databases such as the NCHS NVSS are also a challenge. The third primary challenge in the above analyses is the evaluation of significance within the results. Due to the large sample size for both NTSV and elective cesarean deliveries analyses, 4,631,318 and 1,138743 observations respectively, the majority of the relationships between cesarean deliveries, geography, and the covariates of interest are, for the most part, statistically significant. While the results of these analyses may indicate statistical significance this does not inherently indicate clinical significance (Ranganathan et al., 2015; Sharma, 2021). The statistically significant results in this study instead indicate that the likelihood of cesarean delivery based on the primary predictor or covariates of interest is not due to chance (Ranganathan et al., 2015; Sharma, 2021). Additional research within hospitals and health care facilities and using data from such sources would be necessary to indicate clinical significance of the relationship between cesarean delivery and geography, and the additional covariates of interest. As such the first solution to this challenge, is to note the limitation sample size places on the results within the discussion section. Second, is to place, in part, the impetus of discerning the most pertinent and significant relationships on the reader and offer potential avenues for further research on these issues.

Community Partners

Community partners are of critical importance in public health research and practice, as they provide connect researchers to their target populations and provide recommendations and perspective on the feasibility and acceptability of interventions (*Identifying and Determining Involvement of Stakeholders*, n.d.). There are a broad range of partners involved and interested in the above research. First, other researchers who are also interested in women's health outcomes, and more specifically perinatal and birth outcomes. Second, national level policy makers such as the Joint Commission on the Accreditation of Healthcare Organizations, the Centers for Medicare and Medicaid Services, and the U.S. Department of Health and Human Services Health People Initiative as they all have a vested interest in the reducing the rates of NTSV cesarean deliveries. Additionally, the National Center for Vital Statistics from the Centers for Disease Control and Prevention would also be another example of a national level community partner.

The process by which the aforementioned community partners were engaged in the development and completion of this dissertation is multi-fold. First, national level community partners were engaged via metric and data source selection. NTSV cesarean delivery rates are a common perinatal quality of care metric utilized by several major health organizations in the U.S., including but not limited to Joint Commission on the Accreditation of Healthcare Organizations, the Centers for Medicare and Medicaid Services, the Agency for Healthcare Quality and Research, and the U.S. Department of Health and Human Services Health People Initiative. As such, focusing on this metric as the outcome of this dissertation creates a vested interest from these organizations and their constituents in these results. Similarly, in utilizing publicly available data from NCHS, we engage both the NCHS but also other researchers who utilize this database in their research on maternal and child health research. Additionally, community partners in the field of maternal child health and women's health research were engaged through the systematic review of the current body of scholarly literature which was integral in the development of the rationale for this dissertation and the methodology of the above analyses. Further, community partners within East Tennessee State University were engaged in the development of this dissertation via discussions on methodology and through the presentation of the findings of this dissertation.

Chapter 5. Discussion

Introduction

This study examined trends in a well-established measure of the quality of perinatal care, low risk nulliparous, term, singleton, vertex (NTSV) cesarean deliveries in the United States (U.S.) overall and in culturally specific sub-regions of the U.S. Overutilization of cesarean deliveries has been associated with increased risk for adverse health outcomes for mothers and infants (Oakes et al., 2019; Sandall et al., 2018). Additionally, overutilization of cesarean deliveries among low-risk pregnancies has also been associated with lower reported quality of care and higher health care expenditures (Fisher & Welch, 1999; Hoxha et al., 2019; Oakes et al., 2019; Roth & Henley, 2014; Shaw et al., 2016; Wennberg, 2004). The first aim examined the trends in NTSV cesarean deliveries, and secondarily the trends in elective cesarean deliveries in the U.S. Elective cesareans, which are defined as a NTSV cesarean delivery in which no trial of labor was attempted, is an important sub-set to consider as these operations are likely performed for convenience, fear, or other non-medical reasons. The second aim examined the extent to which the trends in NTSV and elective cesarean deliveries are mirrored in Appalachia, a region which historically has been plagued by poor access to health care resources and poor health outcomes (Marshall et al., 2017; Meit et al., 2017a; *The Appalachian Region - Appalachian Regional Commission*, n.d.).

Aim 1

The findings of this study indicate that the prevalence of NTSV cesarean deliveries does not vary significantly based Urban Influence Code classifications. It was hypothesized that the rates of NTSV cesarean deliveries would be significantly higher in metropolitan areas, which tend to have the lowest rate of health professional shortages, compared to rural areas. However, after adjustment for covariates of interest and contrary to expectation, there was no significant difference in the odds of NTSV cesarean delivery among women who live in urban, metropolitan areas compared to women who live in rural, non-core non-adjacent areas. These findings suggest that environmental characteristics, such as geographic designation and healthcare resources, may not be the primary drivers in the variations of NTSV cesarean deliveries in the U.S. It is likely that other factors, particularly health system related factors, which are not collected on birth records are more significant drivers of the variations in NTSV cesarean deliveries. This supposition is supported by previous research in which institutional characteristics including hospital ownership, volume, and staffing capacity are all associated with variations in NTSV and elective cesarean deliveries (Bailit, 2012; Boyle & Reddy, 2012; Henke et al., 2014; Janakiraman et al., 2011; Vanderlaan et al., 2020; Weimer et al., 2019). Additional factors such as provider characteristics and practice patterns, which this analysis was unable to measure, may also be important drivers. The current body of literature has consistently found that provider characteristics significantly influence the likelihood of cesarean deliveries (Bailit, 2012; Coonrod et al., 2008; Hoxha et al., 2020; Kozhimannil, Law, et al., 2013; McClelland et al., 2017).

While the findings did not indicate a significant difference in the prevalence of NTSV cesarean deliveries based on rurality, results indicate that there were significant differences in the prevalence of NTSV cesarean deliveries over time. Of particular note, is that across the UIC designations the adjusted prevalence of NTSV cesarean deliveries increased from 2016 to 2020. A potential explanation for the continuing rise in NTSV cesarean deliveries across the study period is the rising medico-legal liability associated with childbirth. The pressures of this liability have alienated physicians from specializing in obstetrics, which further exacerbates existing disparities in the availability of health care resources across the U.S. (Mylonas & Friese, 2015; Prasad et al., 2018). Additionally, medico-legal pressures have influenced physician practice patterns (Abenhaim et al., 2007; Barber et al., 2011; Mushinski et al., 2021; Mylonas & Friese, 2015). Rising liability and insurance premiums have moved providers towards more defensive practice patterns and the use of operative deliveries to maintain greater control over the birthing process and to reduce potential liability (Abenhaim et al., 2007; Barber et al., 2011; Matevosyan, 2015; Mushinski et al., 2021; Mylonas & Friese, 2015). The findings of this analysis indicate the need for additional large-scale research on the influence of institutional and provider characteristics on NTSV cesarean deliveries, as many current studies in the body of scholarly research are cross-sectional or focus on single institutions or health systems.

After examining the prevalence of NTSV cesarean deliveries in the U.S. by UIC classification, the women within the sample who had a NTSV cesarean delivery were sub-set and analyzed to determine the variations in elective cesarean deliveries. Of the approximately 1.1 million low-risk cesarean deliveries in the U.S. between 2016 and 2020, 37% were found to be elective, or performed without a trial of labor. It is important to consider the proportion of women who had elective cesarean deliveries as these procedures may be performed out of convenience or fear on the provider's and mother's part. Previous research has indicated that rising malpractice premiums and fear of potential liability influences a provider's decision to perform a NTSV or elective cesarean delivery (Barber et al., 2011; Henke et al., 2014; Panda et al., 2018; Reyes & Rosenberg, 2019). Further, that lack of health care resources and cooperation among health care professionals also influences a provider's decision-making around performing a cesarean delivery among low-risk women (Barber et al., 2011; Henke et al., 2014; Panda et al., 2018; Reyes & Rosenberg, 2019). Fear is also a major driver of elective cesarean delivery on maternal request, current research has indicated that women who reported being fearful of childbirth were significantly more likely to have a cesarean delivery compared to women who did not report fear of childbirth (Betrán et al., 2018; Jenabi et al., 2020; Reyes & Rosenberg, 2019). Provider and mother motivations were not able to be included in this analysis as these two potential explanations are not readily measured or reported on the current revision of the birth certificate.

The findings of this study show that the prevalence of elective cesarean deliveries is significantly different based on UIC classifications and across the study period. Previous research has indicated that women in lower resource communities are at higher odds of cesarean delivery compared to women in higher resource communities (Sandall et al., 2018). It is purposed that because women who live in rural communities, in which they must travel up to 100 miles farther to obtain the same obstetric services as urban women, may choose to plan an elective cesarean delivery to manage their labor and delivery and ensure that their provider is able to care for them (Jenabi et al., 2020; Medicare & Services, 2019). This supposition is contradicted by the finding that the adjusted prevalence of elective cesarean deliveries was lowest among women who lived in non-core non-adjacent areas compared to women who live in metropolitan areas. One potential explanation for the rate of elective cesarean deliveries being lower in non-core non-adjacent, i.e., rural, counties is that these women in these counties have higher rates of common maternal risk factors and higher risk of severe maternal morbidities, as indicated by the current body of scholarly literature (Hansen & Moloney, 2020; Lisonkova et al., 2016; Lu et al., 2003). As such, these women are more likely to require a medically indicated cesarean delivery which in turn would cause a lower rate of elective cesarean deliveries in these rural communities. Additional research, directly comparing women of similar risk profiles in each geography is needed to estimate more clearly the differences in the rates of elective cesarean deliveries in the U.S.

While the overall rate of cesarean deliveries has increased over the last several decades, this study finds that the prevalence of elective cesarean deliveries has decreased from 2016 to 2020. Metropolitan areas in particular saw the largest decline across the study period, though this is not unexpected as this classification also had the highest prevalence at baseline. This is likely due, in part, to recent revisions to reimbursement policies around elective cesarean deliveries and inductions. Reducing the rates of elective cesareans are a priority area for the Center for Medicare and Medicaid Services (CMS). A number of payment initiatives to reduce the rate of elective cesarean deliveries have been introduced and implemented sporadically across the U.S. (*Medicaid Payment Initiatives to Improve Maternal and Birth Outcomes*, 2019). One such initiative which is potentially driving the decrease in elective cesarean deliveries are reduced payments or nonpayment for elective cesarean sections. Montana Medicaid reduced payments for elective cesareans by 33%, whereas Oklahoma's state Medicaid program dropped the reimbursement rate for elective cesarean deliveries to be equal to the reimbursement for vaginal deliveries (*Medicaid Payment Initiatives to Improve Maternal and Birth Outcomes*, 2019). Recent research conducted by Allen and Grossman, found that nonpayment policies were associated within significant decreases in early-term elective cesarean deliveries among Medicaid enrollees (Allen & Grossman, 2020). In addition to the adoption of revised payment schedules for elective cesarean deliveries in Medicaid programs, private insurers are also following suit and adjusting reimbursements as well.

In this aim, the differences in the odds of having an elective cesarean delivery in the U.S. from 2016 to 2020 by UIC classifications were assessed. Significant variations in the rates of elective low-risk cesarean deliveries were noted amongst women across the different geographic regions. While metropolitan women had the highest prevalence of elective cesarean sections across the study period, they also saw the largest declines in elective cesareans from 2016 to 2020. Conversely, the adjusted prevalence of elective cesarean sections was lowest among women from non-core non-adjacent areas across the study period, but it also had the lowest rates of decline. Further research is necessary to identify and clarify the causal factors associated with the different rates of decline within the different UIC classifications.

Aim 2

The second aim is to then examine the extent to which the variation in NTSV and elective cesarean delivery rates nationally is mirrored in the Appalachian sub-regions. It was hypothesized, based on the existing body of scholarly literature (Henke et al., 2014; Panda et al., 2018; Sandall et al., 2018), that because the Appalachian sub-regions largely have lower levels of health care resources and providers that the prevalence of NTSV cesarean deliveries would be lower. Consistent with the results of Aim 1, the findings of this analysis indicate that the rates of NTSV cesarean deliveries vary significantly based on Appalachian designation. Relative to non-Appalachia, the prevalence of NTSV cesarean deliveries was higher in the Appalachian sub-regions, except for South Central Appalachia. Additionally, significant differences in the rates of NTSV cesarean deliveries across the study period were noted in the marginal analysis. While the results indicate significant differences, these results should be interpreted with caution as the substantial sample size has led to substantial statistical power, but further research would be necessary to examine the clinical significance of Appalachian designation and the associated regional characteristics on variations in NTSV cesarean deliveries. Additionally, over 90% of observations within the analysis of cesarean deliveries by Appalachian designation occurred to women who live outside of the Appalachian region. A potential explanation as to the stark differences in the distribution of births within this Aim, is that while there is a larger proportion of women in Appalachia compared to the national average the population within Appalachia is an aging one (Pollard & Jacobsen, 2021). The median age of Appalachian residents is 41.3 years compared to the national average of 38.4 years (Pollard & Jacobsen, 2021). This indicates that there potentially lower frequencies of women of reproductive age in Appalachia compared to non-Appalachia which potentially skews the findings of this study. However, it should also be noted that women of reproductive age in Appalachia are significantly different compared to women of reproductive age in non-Appalachia. Research has indicated that the pre-conception health of Appalachian women is poorer compared to the pre-conception health of women in non-

Appalachia and further that Appalachian women are at increased risk for pregnancy-related complications and severe maternal morbidities compared to non-Appalachian women (Hansen & Moloney, 2020; Short et al., 2012). The relative proximity of the estimated prevalence of NTSV cesarean deliveries in non-Appalachia and the Appalachian sub-regions suggests that environment may not be the primary driver of the increases in NTSV cesarean deliveries seen in the U.S. over the last several decades. As with national estimates of NTSV cesarean deliveries seen in Aim 1, additional research is necessary to determine which organizational, provider, or individual level factors are most influential on NTSV cesarean delivery rates particularly within the Appalachian sub-regions.

After examining the prevalence of NTSV cesarean deliveries in Appalachia relative to non-Appalachia, the prevalence of elective cesarean deliveries within these regions were also assessed. It is hypothesized that the rates of elective cesarean deliveries would be lower in the Appalachian sub-regions relative to non-Appalachia, and further that rate of elective cesarean deliveries will be highest in Northern Appalachia and lowest in Central Appalachia relative to the other Appalachian sub-regions. The findings of this study show that the prevalence of elective cesarean deliveries is significantly different based on Appalachian designation and across the study period. In line with expectation, the rates of elective cesarean deliveries were significantly lower in the Appalachian sub-regions compared to non-Appalachia, with the exception of Southern Appalachia. Contrary to expectation, Southern Appalachia had the highest prevalence of elective cesarean deliveries compared to non-Appalachia and the other Appalachia sub-regions. Further, Northern Appalachia had the lowest prevalence of elective cesareans.

While recent research has illustrated that Central Appalachia consistently has poorer health outcomes relative to the other sub-regions, which has been attributed to long-standing disparities in socioeconomic status, access to health care providers and affordable providers, in this study Central Appalachia did not have the highest rate of elective cesarean delivery (Hale et al., 2022; Meit et al., 2017a). This finding was inconsistent with the aforementioned hypotheses. Additionally, it was anticipated that Northern Appalachia would have the highest prevalence of elective cesarean deliveries because research has shown that this sub-region has lower proportions of uninsured women, and lower proportions of counties who are economically distressed (Hale et al., 2022). However, Northern Appalachia had the lowest rates of elective cesarean deliveries suggesting that these maternal-level demographic characteristics and enabling characteristics may not be the primary drivers of elective cesareans in the Appalachian sub-regions.

There are several potential explanations for these contrary findings. First, as noted in Aim 1 and supported by the current scholarly evidence, the rates of perinatal complications and common maternal risk factors for cesarean delivery are higher in Appalachian women compared to non-Appalachian women (Hale et al., 2022; Hansen & Moloney, 2020). Therefore, women in Appalachia and its subregions, particularly Central Appalachia, likely have higher rates of medically indicated cesarean deliveries which therefore lower the rates of elective cesarean deliveries. Second, Northern Appalachia is a predominantly metropolitan sub-region of Appalachia compared to the other sub-regions with higher levels of health care resources (Hale et al., 2022). It is possible that health care facilities and policy makers within this region have implemented interventions to reduce non-medically indicated cesarean such as new guidelines on the provision of elective cesarean deliveries or reimbursement structure revisions, which we are unable to measure via the birth certificate, which has lowered the rate of elective procedures within this region. Additional research using data sets which can account for institutional characteristics is necessary to elucidate the factors associated with the inter-regional variations of elective cesarean deliveries beyond what is able to be measured from the birth certificate, such research would allow for the creation of actionable policy change.

In line with the results of Aim 1, this analysis finds that the prevalence of elective cesarean deliveries by Appalachian has decreased significantly from 2016 to 2020. As noted above, these decreases may be driven by the changing reimbursement structure in the U.S. around elective cesarean deliveries (*Medicaid Payment Initiatives to Improve Maternal and Birth Outcomes*, 2019). Another potential driver of the variations in elective cesarean deliveries within Appalachia and across the study period are the cultural and social norms within the sub-regions. Research has suggested that a woman's beliefs and choices regarding childbearing and birth are predominantly shaped by their cultural belief system (Miller & Shriver, 2012). Appalachia as a region has a rich cultural identity. Historically, Appalachians tend to distrust outsiders, particularly health care providers, and base the majority of their health care decisions on experiential stories from family, peers, and neighbors (Bachman et al., 2018; Behringer & Friedell, 2006; Katz et al., 2007). Cultural influences on health care decision making have been largely overlooked in the current body of scholarly literature, and as such future research endeavors should seek to quantify cultural and peer influences on elective cesarean deliveries in order to inform the development of targeted interventions and policies which are both culturally acceptable and efficient.

In this aim, the differences in the prevalence of elective cesarean deliveries in the Appalachian sub-regions were assessed. Significant variations in the rates of elective cesarean deliveries were noted in Appalachia relative to non-Appalachia, as well as within the Appalachian sub-regions. Of particular interest, is that the rates of NTSV cesarean deliveries are higher in Appalachia compared to non-Appalachia, whereas the rates of elective cesarean deliveries are lower in non-Appalachia compared to non-Appalachia. This finding may suggest that women in the Appalachian sub-regions are less likely to undergo an elective procedure due to the higher rates of perinatal risk factors (Hansen & Moloney, 2020). Additional research on the rates of medically indicated cesarean deliveries by Appalachian designation is needed determine if the rate of medically-indicated procedures is driving down the rate of elective cesarean sections. These findings add to an emerging body of evidence that heath and health outcomes in Appalachia are more nuanced than previously known. Further, that it is important to examine outcomes at the sub-regional level to uncover important variations and create actionable recommendations to reduce the rates of NTSV and elective cesarean deliveries within this region.

Implications of Andersen Healthcare Utilization Model

As previously mentioned, the Andersen Healthcare Utilization Model was employed because it encompasses both individual and broader contextual factors which dictate the use of healthcare services (Andersen, 1995). This framework was used to not only guide the review of the current body of scholarly literature around variations in cesarean delivery rates but also guided variable selection and inclusion for the adjusted analyses described above. This dissertation and its associated analyses provide evidence to support the utilization of the Andersen Healthcare Utilization Model for health services research on women's health services and outcomes. The Andersen Healthcare Utilization Model accounted for both the individual and broader contextual factors which significantly influence variations in cesarean delivery rates ensuring that those factors did not confound the findings of these analyses. Through illustrating and contextualizing the significant factors associated with variations in cesarean delivery among low-risk women, the utilization of this model increases the applicability of these results for the development of organizational interventions or policy revisions to cater to the needs of specific target populations.

Strengths and Limitations

This study has several strengths. First, this study adds to the existing body of scholarly literature by updating the current estimations of low-risk NTSV cesarean births and elective low-risk cesarean deliveries in the U.S. and in the Appalachian sub-regions, as well as looking at those trends longitudinally. Second, these analyses address a common criticism of the low-risk NTSV subset of cesarean delivery research by including common behavioral and health risk factors which may influence the evaluation of medical need. Third, this study addresses a substantial gap in the literature by exploring the trends in elective low-risk cesarean sections over time. Historically, it has been difficult to measure the prevalence of elective cesarean sections and as such previous studies tend to focus on cross-sectional data sets within single institutions. In this study, because the 2003 revision of the birth records directly asks, "Was a trial of labor attempted?” we were able to approximate the rate of elective cesarean deliveries more clearly. Lastly, this study uses a well-established, large data source to examine these important issues.

However, this study is not without its limitations. First, this study did not attempt to elucidate the causes of the differences in the odds of NTSV or elective cesarean deliveries over the study period. This remains an important area for future research. Concurrently, the impact of the 2018 decision by the Joint Commission, an independent organization responsible for the accreditation of health care facilities within the U.S., to begin publicly reporting the rates of NTSV cesarean deliveries or other regional health policies and interventions were not assessed in this study. Second, because income data is not collected on the birth certificate, the ARC economic classifications were used a proxy measure to account for its influence on NTSV and elective cesarean deliveries. While the ARC economic classification system has been employed by several recent studies on variations in health outcomes (Hale et al., 2022; Meit et al., 2017a; Roberson et al., 2019; Sohn et al., 2016), this study applied this county-level assessment of socioeconomic vulnerability to individual women leading to the potential for bias due to misclassification. Similar bias could be associated with the use of the Area Health Resource File’s Health Professional Shortage Area designations to account for variations in health care resources, particularly for women who live in disperse rural counties.

Conclusion

This study examined the differences in the likelihood of both NTSV and elective cesarean deliveries in the U.S. based on different geographies. As far as the author is aware, this is the first study to examine these outcomes in Appalachian sub-regions relative to national averages. Additionally, this study addresses a gap in the current body of scholarly literature by providing more recent estimations in the trends of these outcomes. Another gap in the literature addressed by this study is there are few to no studies which examine the longitudinal differences in elective cesarean deliveries in the U.S., because historically it has been difficult to define and measure.

The findings of the prevalence of NTSV cesarean deliveries by UIC classifications and Appalachian designations remained relatively stable across the study period. These findings indicate a need for further attention and intervention for this issue. As aforementioned, previous research indicates that providers adapt their practice patterns for a number of reasons, be that to avoid litigation or to “preserve” their personal time. As such future research and interventions should focus on policy level actions such as staffing capacity and institutional level policies around labor management. Research has shown that the “traditional” model of staffing has a direct impact on physician practice behaviors towards delaying or expediting labor by withholding labor inducing drugs or utilizing cesarean delivery when those births fall outside working hours (Bailit, 2012; Brown, 1996; Burns et al., 1995; Roth & Henley, 2014; Son et al., 2020). As such, alternative models should be explored and employed to reduce NTSV and elective cesarean delivery rates.

While recent efforts have been made among public and private insurers to reduce low-risk and elective cesarean deliveries through payment initiatives, policy makers should also focus their future efforts on advocating for the expansion of insurance coverage to alternative perinatal care providers, such as midwives and doulas. Studies have consistently shown that women who receive care from midwives and doulas have lower rates of cesarean deliveries compared to women attended by physicians (Chen et al., 2018; Hodnett et al., 2013; Kozhimannil, Attanasio, et al., 2014; Kozhimannil, Hardeman, et al., 2013, 2016; Nijagal et al., 2015). In addition to lower rates of cesarean deliveries, care provided by midwives and doulas has been shown to be a cost-effective method of approach to decreasing the overutilization of cesarean sections, as well as improve the perceived quality of care received (Chaillet et al., 2015; Hodnett et al., 2013; Kozhimannil, Attanasio, et al., 2014; Kozhimannil, Hardeman, et al., 2013). It should be noted that midwives and doulas tend to provide care to women with low-risk pregnancies compared to obstetricians.

The findings of the examinations of elective cesarean deliveries in the U.S. showed that the prevalence of elective cesarean deliveries varied significantly by geography, both UIC classifications and Appalachian designations, and over the study period. As aforementioned, these findings add another layer of nuance to our current understanding of Appalachian health, suggesting that while Appalachia may have higher rates of poor health outcomes that the overutilization of health services may not be a primary driver of those poor health outcomes.

In conclusion, the findings of these studies have important public health implications for both future research and practice. First, it identifies areas in which the prevalence of NTSV and elective cesarean deliveries are the greatest; thus, indicating potential overutilization of healthcare services. Additionally, this research can serve as a foundation for future research on these outcomes within and outside of Appalachia, as well as interventions to reduce the overutilization of NTSV and elective cesarean deliveries in the U.S.

Chapter 6. Communication and Dissemination Plan

Introduction

This study examined current variations in low-risk nulliparous, term, singleton, vertex (NTSV) and elective cesarean deliveries in the United States and within Appalachia. The second purpose was to disseminate the findings of these examinations to pertinent stakeholders whose interests includes women's health, maternal child health, and reproductive health. In Chapter 1, the proposed field-based products which can be shared with relevant parties included an evidence matrix, manuscript, and policy brief. There is a broad range of community partners and stakeholders who would have a vested interest in this research including but not limited to women and their families, public and private organizations focused on women's health, public and private insurers, employers, and health researchers. In this chapter, the proposed competencies for this dissertation will be revisited and assessed to determine how well the design of this study addressed said competencies. Additionally, the results and their implications of this study will be addressed in relation to the competencies and how they will be communicated to both local and broad stakeholders and partners.

Attainment of Competencies

This study adds to the current body of scholarly literature and brings attention to low-risk and elective low-risk cesarean deliveries, two important public health issues, while also integrating and addressing key competencies. Integration of competencies and the attainment of such competencies can be found in Table 18.

Table 18

Competency Integration and Implications

Area	Description	Design	Results	Implications
Data & Analysis	Explain qualitative, quantitative, mixed methods and policy analysis research and evaluation methods to address health issues at multiple (individual, group, organization, community, and population) levels.	Chapter 3: Quantitative analysis of publicly available secondary data. Field-Based Products: Manuscript for targeted dissemination to women's health researchers Issue brief for broader dissemination to diverse stakeholders	Examined the rates of low-risk and elective low-risk cesarean deliveries at multiple levels (national and regional) using individual level data. Made note in *Analytic Approach* section that logistic regression was utilized due to the nature of the outcome variable, i.e., categorical. For both the manuscript (Field-Based Product 2) and the issue brief (Field-Based Product 3) the results of this quantitative analysis were reported and explained to stakeholders at multiple levels.	Communication is one of the ten essential services of public health. Communicating effectively with a broad and diverse audience ensures that the knowledge will lead to actionable change. This dissertation explains the methodologies and results of quantitative data analyses on the variations in NTSV and elective cesarean section which will help policy makers address the issue at multiple levels, such as the national and institutional levels.

Programs & Policies	Integrate knowledge of cultural values and practices in the design of public health policies and programs.	Chapter 2: Review pertinent literature to identify influence cultural values and practices on low-risk and elective low-risk cesarean deliveries. Chapter 5: Use information collected from review of the literature to provide context to the results of the analyses.	Identified the influence of cultural values on low-risk and elective low-risk cesarean deliveries at the patient level and at the provider level. Cultural values, referring to both personal values and broader social norms, influence not only a woman's choice to seek out health care services but also a provider's likelihood to perform that service. Additionally, specific cultural norms and values were identified among Appalachian women relative to women who live outside of Appalachia.	Culture and cultural belief systems are important factors which influence the utilization of health services. However, the influence of culture on health behaviors has been largely overlooked in the current body of scholarly literature. While this study is not able to quantify the association between culture and cesarean section utilization, it does note the importance of culture, particularly in Appalachia, and makes clear recommendations for future research that are acceptable, feasible, and effective.
Education & Workforce Development	Deliver training or educational experiences that promote learning in academic, organizational and community settings.	Chapter 6: Dissemination of findings to academic conferences and to pertinent stakeholders	The findings of this dissertation were adapted into abstract form and will be submitted to the CityMatCH and APHA 2023 annual conferences.	This competency is attained by providing an education about low-risk and elective cesarean deliveries in the U.S. and in Appalachia to academic peers through my

			Disseminated the findings of this dissertation to research colleagues at ETSU and to leadership of the STRONG Accountable Care Organization.	dissertation defense and presentations at academic conferences. The findings will be delivered to organizational setting by sharing the results with the STRONG Accountable Care Community at Ballad Health.
Leadership Management & Governance	Propose strategies for health improvement and elimination of health inequities by organizing stakeholders, including researchers, practitioners, community leaders, and other partners.	Chapter 5: Identify gaps current research, as well as limitations in analysis approach Propose recommendations for future research and practice efforts Chapter 6: Develop issue brief that provides policy recommendations to help reduce disparities in low-risk and elective cesarean deliveries	Gaps identified in the current literature include, but are not limited to, lack of large-scale studies assessing the influence of institutional characteristics on cesarean delivery rates, and lack of research on the cultural influences on the utilization of cesarean sections. Limitations of this analysis stem predominantly from the data set and as such future research recommendations include repeating these analyses with data sets that account for institutional characteristics as well as women's	To propose strategies to improve health outcomes, in this case reduce the prevalence of low-risk and elective cesarean deliveries, I organized several stakeholders. First, I identified that the nulliparous, term, singleton, vertex cesarean delivery rate as a key of perinatal quality of care. Additionally, I determined that local stakeholders, such a Ballad Health STRONG ACC and ETSU Center for Applied Research and Evaluation in Women's Health, were interested in this subject as

			health beliefs and perceptions. Issue brief on the variations in low-risk and elective cesarean deliveries in Appalachia relative to national averages was developed as the dissemination product for this chapter. This issue brief contains several policy recommendations to reduce the rates of low-risk and elective cesarean deliveries.	well. Further, I engaged fellow researchers to identify gaps in the existing literature which need to be addressed and evidence-based policies and interventions which can recommended to organizational stakeholders.
Leadership Management & Governance	Communicate public health science to diverse stakeholders, including individuals at all levels of health literacy, for purposes of influencing behaviors and policies.	Chapter 6: Develop strategy for dissemination of study findings to both local, targeted stakeholders and broader audiences Field-Based Products: Manuscript for targeted dissemination to women's health researchers Issue brief for broader dissemination to	A two-part strategy was developed to disseminate the findings of this dissertation to pertinent stakeholders. Findings will be disseminated to local and regional stakeholders via the dissertation defense, and an issue brief. Additionally, if stakeholders are interested, findings will be presented to organizational staff and leadership at community	As above clear communication is essential to public health research and practice. This competency was attained through the development of field-based products for the dissemination of results to various stakeholders of diverse backgrounds. Through this competency additional skills in identifying stakeholder priorities and applying those priorities to create targeted

		diverse stakeholders	stakeholders, such as the STRONG ACC. Findings will be disseminated to broader stakeholders via presentations at academic research conferences and through the publication of results in peer-reviewed journals.	communications which lead to more actionable change.
Health Services Management & Policy	Integrate individual health information, population health measures and community resources to redesign health service delivery and improve population health.	Chapter 3: Include measures of individual and population health in adjusted logistic regression Chapter 5: Identify strategies and make recommendations to redesign health services delivery	In the review of the current body of scholarly literature, influential individual, community, organizational, and population factors were identified as being associated with variations in low-risk and elective cesarean deliveries. These factors were accounted for in the adjusted analyses. Based on the findings of the adjusted analyses, which can be found in the Appendices, strategies and recommendations were identified and proposed in the discussion section.	Health behaviors, utilization of health services, and consequently health outcomes are driven by a myriad of factors ranging from individual biology and health behaviors to community level resources and access to health care, and more. As such, this competency was attained through the inclusion of such factors in the analyses. Additionally, because some influential factors were not available within the data source used, a review of the scholarly literature aided in the development of targeted

				recommendations to reduce low-risk and elective cesarean delivery rates.
Health Services Management & Policy	Assess the effectiveness of public health and healthcare services aimed at improving population health using applied research methods.	Chapter 1: Systematically review current interventions and policies which address cesarean delivery rates in the U.S. Chapter 5: Integrate information on current policy and practice interventions to provide context to results and make recommendations	A broad range of interventions at the individual, organizational, and policy level were identified in the review of the current body of scholarly literature. The effectiveness of these interventions was measured based on the findings of peer-reviewed scholarly articles, systematic reviews, and meta-analyses conducted by researchers and organizations, such as the Cochrane Library. Assessing the effectiveness of current interventions to reduce low-risk and elective cesarean sections was utilized, in part, to illustrate how amenable this issue is to change.	This competency was attained through the systematic review of the current body of scholarly literature. While this study was unable to assess the efficacy or influence of current policy and practice interventions on the trends in low-risk and elective cesarean deliveries in the U.S. and Appalachia, the results due highlight that geography and resources may not be the primary driver of these variations. This suggests that interventions focused on such characteristics would not be as effective as, for example, interventions focused on institutional characteristics.

Health Services Management & Policy	Analyze patterns of health services utilization, costs, and outcomes and health system performance using applied research methods.	Chapter 2: Systematic review of the current body of scholarly literature Chapter 5: Analyze the current utilization of low-risk and elective cesarean deliveries in the U.S. between 2016-2020	The systematic review of literature on cesarean deliveries in the U.S. illustrated a pattern of overutilization and therefore poorer health outcomes, poorer quality of care, and higher health care expenditures. Additionally, this overutilization exacerbates health inequities present in the U.S. and Appalachia. The current patterns of health care services utilizations were analyzes using adjusted logistic regression modeling and marginal analysis. The findings of this analysis indicate no significant variation in NTSV cesareans by geography, however there were substantial differences in the rates of elective cesareans nationally and within the Appalachian sub-regions.	This study addressed several gaps in the current body of scholarly literature including providing more recent estimates of the longitudinal changes in low-risk deliveries in the U.S. Additionally, this study provided estimations in the longitudinal changes in elective cesarean deliveries, a metric which has been historically difficult to assess. This study provides evidence to support the need for additional intervention to reduce the rates of low-risk cesarean deliveries in the U.S. because while there were not significant differences in the prevalence over the study period, this stagnation suggests that the current interventions are no longer effective.

Dissemination Strategy

Three field-based products have been developed for dissemination to key stakeholders and practice partners in Appalachia, as well as interested parties outside of Appalachia. The proposed field-based products are 1) an evidence matrix, 2) a manuscript detailing the research efforts to address Aims 1 and 2, and 3) an issue brief on low-risk cesarean deliveries. An evidence matrix is a mapping tool that can be utilized to organize and synthesize the current body of literature on a given topic in the hopes of identifying gaps in knowledge and prioritizing future research (Anstee et al., 2011). The evidence matrix serves as an overview of the current body of scholarly literature on NTSV and elective cesarean deliveries in the United States. The manuscript, Field-Based Product 2, addresses Aim 1.2 and 2.2 and will be disseminated via peer-reviewed journal, such as the Journal of Appalachian Health. The final product, the issue brief, reports on the findings of the analysis, specifically Aim 2, with specific emphasis on the policy implications and policy level recommendations to reduce low-risk and elective low-risk cesarean deliveries in Appalachia. Stakeholders with whom the issue will be shared include healthcare organizations, employers, public and private insurers. The issue brief will be specifically disseminated to regional healthcare systems and facilities, such as Ballad Health and East Tennessee State University Obstetrics and Gynecology clinic. It will be noted in initial dissemination communications that those facilities are free to share this product with organizational partners. Broader findings of these analyses will be presented to their organizational leadership and strategic partners on request. Additionally, findings will be distributed through the Center for Applied Research and Evaluation in Women's Health at East Tennessee State University.

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APPENDICES

Appendix A: Additional Tables of Interest

Table 19

Maternal Characteristics by Urban Influence Code among NTSV Pregnancies in the U.S. 2016-2020, Frequency (95% C.I.)

	Metropolitan Areas (n=4,054,252)	**Micropolitan Areas (n=352,227)**	**Non-core Adjacent (n=191,815)**	**Non-core Non-adjacent (n=32,625)**
Environmental Characteristics				
*Health Professional Shortage Area Designations**				
None Designation	6.92 (6.90, 6.95)	11.93 (11.82, 12.04)	7.33 (7.22, 7.45)	6.73 (6.46, 7.01)
Parts Designation	91.11 (91.08, 91.13)	75.93 (75.79, 76.07)	57.15 (56.93, 57.37)	71.48 (70.98, 71.96)
Whole Designation	1.96 (1.95, 1.98)	12.14 (12.03, 12.25)	35.52 (35.31, 35.73)	21.80 (21.35, 22.25)
Predisposing Characteristics				
*Maternal Age**				
19 Years & Younger	10.92 (10.89, 10.95)	17.76 (17.64, 17.89)	19.26 (19.08, 19.44)	18.39 (17.97, 18.81)
20-34 Years	79.65 (79.61, 79.69)	78.16 (78.02, 78.29)	77.46 (77.27, 77.64)	77.84 (77.39, 78.30)
35 Years & Older	9.43 (9.40, 9.46)	4.08 (4.02, 4.15)	3.28 (3.20, 3.36)	3.76 (3.56, 3.97)
*Maternal Race/Ethnicity**				
Non-Hispanic White	51.01 (50.96, 51.05)	72.21 (72.07, 72.36)	77.33 (77.15, 77.52)	75.71 (75.24, 76.18)
Non-Hispanic Black	13.09 (13.06, 13.12)	8.19 (8.10, 8.28)	9.39 (9.26, 9.52)	4.00 (3.79, 4.22)
Hispanic	23.93 (23.89, 23.97)	13.37 (13.26, 13.48)	8.52 (8.39, 8.64)	9.25 (8.94, 9.57)
Non-Hispanic Other	11.97 (11.94, 12.00)	6.22 (6.14, 6.30)	4.76 (4.67, 4.86)	11.04 (10.70, 11.38)
*Maternal Educational Attainment**				
Less than a High School Diploma	9.43 (9.40, 9.46)	13.20 (13.08, 13.331)	14.16 (14.00, 14.32)	13.14 (12.78, 13.51)
High School Diploma or Equivalent	23.23 (23.19, 23.27)	30.61 (30.46, 30.76)	33.50 (33.29, 33.71)	30.29 (29.79, 30.79)
Some College or Associate's Degree	26.18 (26.13, 26.22)	31.93 (31.78, 32.09)	32.50 (32.29, 32.71)	33.14 (32.63, 33.65)
Advanced Degrees	41.17 (41.11, 41.21)	24.26 (24.12, 24.40)	19.84 (19.66, 20.02)	23.43 (22.98, 23.90)
*Maternal Weight+**				
Underweight	4.15 (4.13, 4.17)	3.97 (3.91, 4.04)	3.92 (3.84, 4.01)	3.64 (3.44, 3.85)
Normal Weight	48.92 (48.87, 49.97)	42.66 (42.50, 42.83)	40.76 (40.54, 40.98)	42.79 (42.25, 43.33)
Overweight	25.10 (25.06, 25.14)	25.10 (24.96, 25.25)	25.17 (24.98, 25.37)	25.51 (25.04, 25.99)
Obese	17.97 (17.93, 18.01)	22.36 (22.23, 22.50)	23.65 (23.46, 23.84)	22.30 (21.85, 22.76)
Extremely Obese	3.86 (3.84, 3.88)	5.90 (5.83, 5.98)	6.50 (6.39, 6.61)	5.75 (5.50, 6.01)
*Trimester Prenatal Care Began**				

First Trimester	79.37 (79.33, 79.41)	78.56 (78.43, 78.70)	78.91 (78.73, 79.10)	78.53 (78.08, 78.97)
Second Trimester	14.78 (14.75, 14.82)	16.16 (16.04, 16.29)	16.09 (15.93, 16.29)	16.18 (15.78, 16.59)
Third Trimester	4.49 (4.47, 4.51)	4.37 (4.30, 4.43)	4.17 (4.08, 4.26)	4.67 (4.45, 4.91)
No Prenatal Care	1.36 (1.35, 1.37)	0.91 (0.88, 0.94)	0.83 (0.79, 0.87)	0.62 (0.54, 0.71)
Enabling Characteristics				
ARC Economic Classification++*				
Attainment	18.02 (17.98, 18.05)	5.69 (5.61, 5.76)	3.15 (3.08, 3.23)	8.06 (7.77, 8.37)
Competitive	20.07 (20.03, 20.11)	9.72 (9.63, 9.82)	9.37 (9.24, 9.50)	16.70 (16.30, 17.11)
Transitional	56.54 (56.49, 56.59)	59.39 (59.23, 59.56)	45.07 (44.85, 45.29)	39.22 (38.70, 39.76)
At-risk	3.63 (3.61, 3.64)	16.71 (16.59, 16.84)	26.71 (26.52, 26.91)	11.42 (11.08, 11.77)
Distressed	1.75 (1.73, 1.76)	8.48 (8.39, 8.57)	15.69 (15.53, 15.85)	24.59 (24.12, 25.06)
*Payment Method**				
Private Insurance	57.77 (57.72, 57.81)	47.79 (47.62, 47.95)	45.57 (45.34, 45.79)	45.89 (45.34, 46.43)
Medicaid	34.94 (34.90, 34.99)	44.27 (44.10, 44.43)	47.72 (47.50, 47.95)	47.42 (46.88, 47.97)
Self-Pay	3.43 (3.42, 3.45)	3.52 (3.46, 3.58)	3.84 (3.75, 3.92)	2.96 (2.78, 3.15)
Other	3.86 (3.84, 3.88)	4.42 (4.36, 4.49)	2.87 (2.80, 2.95)	3.73 (3.53, 3.94)
Day of Birth+++*				
Weekday	76.06 (76.02, 76.10)	79.07 (78.93, 79.20)	80.07 (79.89, 80.25)	78.71 (78.27, 79.15)
Weekend	23.94 (23.90, 23.99)	20.93 (20.80, 21.07)	19.93 (19.75, 20.11)	21.29 (20.85, 21.73)
*Time of Birth**				
0:00-4:00	13.75 (13.72, 13.79)	12.47 (12.36, 12.58)	12.21 (12.06, 12.36)	12.83 (12.47, 13.20)
4:01-8:00	12.84 (12.81, 12.87)	11.69 (11.58, 11.79)	11.52 (11.38, 11.67)	11.96 (11.62, 12.32)
8:01-12:00	16.57 (16.53, 16.61)	15.93 (15.81, 16.05)	15.77 (15.61, 15.93)	15.96 (15.56, 16.36)
12:01-16:00	19.26 (19.23, 19.30)	20.28 (20.15, 20.41)	20.77 (20.59, 20.95)	19.58 (19.15, 20.01)
16:01-20:00	20.02 (19.98, 20.06)	21.91 (21.77, 22.05)	22.30 (22.11, 22.49)	21.99 (21.54, 22.44)
20:01-23:59	17.55 (17.52, 17.59)	17.73 (17.60, 17.85)	17.43 (17.26, 17.60)	17.68 (17.27, 18.10)
Need Characteristics				
*Smoking During Pregnancy**				
Yes	3.21 (3.19, 3.23)	9.51 (9.42, 9.61)	10.71 (10.57, 10.85)	11.58 (11.24, 11.94)
No	96.79 (96.77, 96.81)	90.49 (90.39, 90.58)	89.29 (89.15, 89.43)	88.42 (88.06, 88.76)
*Gestational Diabetes**				
Yes	5.39 (5.37, 5.41)	5.18 (5.11, 5.26)	5.09 (4.99, 5.19)	5.70 (5.45, 5.96)
No	94.61 (94.59, 94.63)	94.82 (94.74, 94.89)	94.91 (94.81, 95.01)	94.30 (94.05, 94.55)
*Hypertension**				
Yes	9.37 (9.34, 9.40)	11.08 (10.98, 11.18)	11.90 (11.75, 12.04)	11.94 (11.59, 12.30)
No	90.63 (90.60, 90.66)	88.92 (88.82, 89.02)	88.10 (87.96, 88.25)	88.06 (87.70, 88.41)
*Sexually Transmitted Infections**				
Yes	2.70 (2.68, 2.71)	3.84 (3.78, 3.90)	3.79 (3.70, 3.88)	3.98 (3.78, 4.20)
No	97.30 (97.29, 97.32)	96.16 (96.10, 96.22)	96.21 (96.13, 96.30)	96.02 (95.80, 96.22)
*Congenital Anomalies**				
Yes	0.22 (0.211, 0.22)	0.33 (0.32, 0.35)	0.33 (0.30, 0.35)	0.43 (0.36, 0.50)
No	99.78 (99.78, 99.79)	99.67 (99.65, 99.68)	99.67 (99.65, 99.70)	99.57 (99.50, 99.64)

+Maternal weight is identified by reported maternal body mass index (BMI) in kg/m^2. Underweight is defined as <18.5 kg/m^2, Normal weight between 18.5-24.9 kg/m^2, Overweight between 25.0-29.9 kg/m^2, Obese between 35.0-39.9 kg/m^2, and Extremely Obese at ≥40.0 kg/m^2.
++The Appalachian Regional Commission Economic Classification system is an index-based classification system that categorizes counties based on their three-year average unemployment rates, poverty rates, and per capita market income. The classifications are attainment, competitive, transitional, at-risk, and distressed. Attainment and competitive classifications represent the most economically stable and account for the top 25% of the counties in the U.S. At-risk and distressed classifications represent the most economically weak counties and account for 25% of all counties in the U.S.
+++The day on which a woman gives birth has been implicated as a factor contributing to the variation in cesarean delivery rates. Consistent with previous literature (Haberman), weekdays are defined within the context of the "normal" work week (Monday-Friday) and weekends are Saturdays and Sundays.
* One-way Analysis of Variance (ANOVA) testing; p<0.001

Table 20

Adjusted Odds of NTSV Cesarean Delivery by Urban Influence Code

Covariate	Odds Ratio	95% Confidence Interval
Environmental Characteristics		
Urban Influence Code		
Metropolitan	Ref	
Micropolitan	0.965	0.956, 0.974
Non-Core Adjacent	0.989	0.977, 1.002
Non-Core Non-Adjacent	0.977	0.951, 1.004
Year		
2016	Ref	
2017	0.996	0.989, 1.003
2018	0.965	0.959, 0.972
2019	0.937	0.931, 0.944
2020	0.929	0.922, 0.936
Health Professional Shortage Area Designations[*]		
None Designation	Ref	
Parts Designation	0.978	0.970, 0.987
Whole Designation	0.980	0.966, 0.995
Predisposing Characteristics		
Maternal Age		
19 Years & Younger	Ref	

20-34 Years	1.585	1.571, 1.599
35 Years & Older	3.176	3.140, 3.213
Maternal Race/Ethnicity		
Non-Hispanic White	Ref	
Non-Hispanic Black	1.371	1.361, 1.381
Hispanic	1.144	1.136, 1.151
Non-Hispanic Other	1.224	1.215, 1.233
Maternal Educational Attainment		
Less than a High School Diploma	Ref	
High School Diploma or Equivalent	1.011	1.002, 1.021
Some College or Associate's Degree	1.039	1.029, 1.050
Advanced Degrees	1.092	1.081, 1.103
Maternal Weight		
Underweight	Ref	
Normal Weight	1.315	1.297, 1.224
Overweight	1.910	1.884, 1.937
Obese	2.725	2.687, 2.764
Extremely Obese	4.548	4.474, 4.624
Trimester Prenatal Care Began		
First Trimester	Ref	
Second Trimester	0.987	0.981, 0.994
Third Trimester	0.962	0.951, 0.973
No Prenatal Care	0.905	0.885, 0.925
Enabling Characteristics		
ARC Economic Classification		
Attainment	Ref	
Competitive	0.996	0.989, 1.004
Transitional	1.040	1.033, 1.047
At-risk	1.120	1.107, 1.133
Distressed	1.159	1.143, 1.177
Payment Method		
Private Insurance	Ref	
Medicaid	0.980	0.974, 0.986
Self-Pay	0.804	0.793, 0.815
Other	0.865	0.854, 0.876
Day of Birth		
Weekday	Ref	
Weekend	0.828	0.824, 0.833
Time of Birth		
0:00-4:00	Ref	

4:01-8:00	1.051	1.042, 1.061
8:01-12:00	1.369	1.358, 1.381
12:01-16:00	1.140	1.131, 1.149
16:01-20:00	1.189	1.180, 1.199
20:01-23:59	1.270	1.260, 1.281
Need Characteristics		
Smoking During Pregnancy		
Yes	1.146	1.133, 1.160
No	Ref	
Gestational Diabetes		
Yes	1.280	1.268, 1.292
No	Ref	
Hypertension		
Yes	1.436	1.426, 1.446
No	Ref	
Sexually Transmitted Infections		
Yes	0.934	0.921, 0.948
No	Ref	
Congenital Anomalies		
Yes	1.613	1.545, 1.684
No	Ref	

Table 21

Maternal Characteristics by Urban Influence Codes among Women who had an Elective Cesarean Delivery 2016-2020, Frequency (95% C.I.)

	Metropolitan Areas (n=998,815)	**Micropolitan Areas (n=84,518)**	**Non-core Adjacent (n=47,512)**	**Non-core Non-Adjacent (n=7,871)**
Environmental Characteristics				
*Health Professional Shortage Area Designations**				
None Designation	6.98 (6.93, 7.03)	11.63 (11.41, 11.85)	7.69 (7.45, 7.93)	6.72 (6.19, 7.30)
Parts Designation	91.09 (91.03, 91.14)	75.91 (75.62, 76.20)	55.63 (55.19, 56.08)	72.96 (71.97, 73.93)
Whole Designation	1.93 (1.90, 1.96)	12.46 (12.24, 12.69)	36.68 (36.25, 37.12)	20.32 (19.44, 21.22)
Predisposing Characteristics				
*Maternal Age**				
19 Years & Younger	6.85 (6.81, 6.90)	12.61 (12.39, 12.84)	14.44 (14.13, 14.76)	13.20 (12.47, 13.97)
20-34 Years	78.33 (78.25, 78.41)	80.41 (80.14, 80.67)	79.86 (79.50, 80.22)	80.22 (79.32, 81.08)
35 Years & Older	14.82 (14.75, 14.89)	6.98 (6.81, 7.16)	5.70 (5.49, 5.91)	6.58 (6.05, 7.15)
*Maternal Race/Ethnicity**				
Non-Hispanic White	49.05 (48.95, 49.14)	70.95 (70.64, 71.25)	75.70 (75.32, 76.09)	76.26 (75.31, 77.19)
Non-Hispanic Black	15.36 (15.29, 15.43)	10.06 (9.857, 10.26)	11.33 (11.05, 11.62)	5.49 (4.99, 5.99)
Hispanic	23.26 (23.17, 23.34)	12.79 (12.57, 13.02)	8.26 (8.02, 8.51)	9.17 (8.55, 9.83)
Non-Hispanic Other	12.34 (12.28, 12.41)	6.21 (6.05, 6.37)	4.70 (4.52, 4.90)	9.10 (8.48, 9.75)
*Maternal Educational Attainment**				
Less than a High School Diploma	7.45 (7.40, 7.50)	10.74 (10.54, 10.95)	11.23 (10.95, 11.52)	10.62 (9.955, 11.32)
High School Diploma or Equivalent	22.12 (22.04, 22.20)	30.49 (30.18, 30.80)	33.74 (33.31, 34.17)	29.56 (28.56, 30.58)
Some College or Associate's Degree	27.44 (27.35, 27.53)	33.68 (33.36, 34.00)	34.61 (34.18, 35.04)	35.07 (34.02, 36.13)
Advanced Degrees	42.99 (42.90, 43.09)	25.09 (24.80, 25.38)	20.42 (20.06, 20.79)	24.76 (23.81, 25.73)
*Maternal Weight+**				
Underweight	2.50 (2.47, 2.53)	2.16 (2.06, 2.26)	2.11 (1.98, 2.24)	2.05 (1.76, 2.39)
Normal Weight	38.49 (38.40, 38.59)	30.01 (29.70, 30.33)	28.07 (27.67, 28.48)	31.34 (30.32, 32.38)
Overweight	26.74 (26.65, 26.82)	24.87 (24.58, 25.17)	24.86 (24.48, 25.26)	24.83 (23.88, 25.80)
Obese	24.83 (24.74, 24.91)	31.02 (30.71, 31.33)	32.31 (31.89, 32.73)	30.22 (29.22, 31.25)
Extremely Obese	7.45 (7.40, 7.50)	11.94 (11.72, 12.16)	12.65 (12.35, 12.95)	11.56 (10.87, 12.29)
*Trimester Prenatal Care Began**				
First Trimester	80.59 (80.51, 80.67)	79.91 (79.63, 80.18)	80.38 (80.02, 80.74)	79.93 (79.02, 80.81)
Second Trimester	14.07 (14.00, 14.14)	15.27 (15.02, 15.51)	15.11 (14.79, 15.44)	15.20 (14.42, 16.02)
Third Trimester	4.19 (4.15, 4.23)	4.02 (3.89, 4.16)	3.80 (3.63, 3.98)	4.36 (3.93, 4.84)
No Prenatal Care	1.15 (1.13, 1.17)	0.81 (0.75, 0.87)	0.70 (0.63, 0.78)	0.50 (0.37, 0.69)
Enabling Characteristics				
*ARC Economic Classification++**				

Attainment	18.00 (17.93, 18.08)	5.27 (5.12, 5.42)	2.77 (2.63, 2.92)	8.42 (7.83, 9.06)
Competitive	19.53 (19.45, 19.60)	8.64 (8.45, 8.83)	8.78 (8.52, 9.03)	16.26 (15.46, 17.09)
Transitional	56.85 (56.75, 56.95)	58.70 (58.37, 59.03)	43.11 (42.66, 43.56)	38.56 (37.49, 39.64)
At-risk	3.74 (3.70, 3.78)	17.9 (17.6, 18.2)	28.41 (28.00, 28.82)	11.17 (10.49, 11.88)
Distressed	1.88 (1.85, 1.90)	9.49 (9.30, 9.69)	16.94 (16.60, 17.28)	25.59 (24.64, 26.56)
Payment Method[*]				
Private Insurance	60.46 (60.37, 60.56)	49.58 (49.24, 49.92)	47.22 (46.77, 47.67)	48.16 (47.05, 49.27)
Medicaid	33.43 (33.33, 33.52)	44.28 (43.94, 44.61)	47.95 (47.50, 48.40)	46.63 (45.53, 47.74)
Self-Pay	2.76 (2.73, 2.79)	2.30 (2.20, 2.40)	2.20 (2.07, 2.34)	2.04 (1.74, 2.37)
Other	3.35 (3.32, 3.39)	3.85 (3.72, 3.98)	2.63 (2.49, 2.78)	3.17 (2.81, 3.59)
Day of Birth[+++*]				
Weekday	78.72 (78.64, 78.80)	81.89 (81.63, 82.15)	83.52 (83.18, 83.85)	82.37 (81.51, 83.19)
Weekend	21.28 (21.20, 21.36)	18.11 (17.85, 18.37)	16.48 (16.15, 16.82)	17.63 (16.81, 18.49)
Time of Birth[*]				
0:00-4:00	12.18 (12.12, 12.25)	10.45 (10.24, 10.65)	9.960 (9.694, 10.23)	10.34 (9.691, 11.04)
4:01-8:00	11.57 (11.51, 11.64)	10.91 (10.70, 11.12)	10.60 (10.33, 10.88)	10.62 (9.962, 11.32)
8:01-12:00	18.45 (18.37, 18.53)	17.53 (17.27, 17.79)	17.59 (17.25, 17.93)	17.89 (17.06, 18.76)
12:01-16:00	18.91 (18.83, 18.98)	18.73 (18.47, 19.00)	19.31 (18.96, 19.67)	18.95 (18.10, 19.83)
16:01-20:00	20.20 (20.12, 20.28)	23.06 (22.78, 23.34)	23.34 (22.96, 23.72)	23.62 (22.70, 24.58)
20:01-23:59	18.69 (18.61, 18.77)	19.32 (19.06, 19.59)	19.20 (18.84, 19.55)	18.57 (17.72, 19.44)
Need Characteristics				
Smoking During Pregnancy[*]				
Yes	3.35 (3.31, 3.38)	10.19 (9.988, 10.40)	11.16 (10.88, 11.45)	12.27 (11.56, 13.02)
No	96.65 (96.62, 96.69)	89.81 (89.60, 90.01)	88.84 (88.55, 89.12)	87.73 (86.98, 88.44)
Gestational Diabetes[*]				
Yes	7.58 (7.53, 7.64)	7.80 (7.62, 7.80)	7.62 (7.39, 7.86)	8.20 (7.61, 8.82)
No	92.42 (92.36, 92.47)	92.20 (92.02, 92.38)	92.38 (92.14, 92.61)	9 1.81 (91.18, 92.39)
Hypertension[*]				
Yes	13.44 (13.38, 13.51)	17.01 (16.76, 17.26)	18.11 (17.77, 18.46)	18.12 (17.28, 18.98)
No	86.56 (86.49, 86.62)	82.99 (82.74, 83.24)	81.89 (81.54, 82.23)	81.88 (81.02, 82.72)
Sexually Transmitted Infections[*]				
Yes	2.40 (2.37, 2.43)	3.63 (3.51, 3.76)	3.50 (3.34, 3.67)	3.59 (3.20, 4.03)
No	97.60 (97.57, 97.63)	96.37 (96.24, 96.49)	96.50 (96.33, 96.66)	96.41 (95.97, 96.80)
Congenital Anomalies[*]				
Yes	0.31 (0.30, 0.32)	0.45 (0.41, 0.50)	0.44 (0.39, 0.51)	0.69 (0.53, 0.90)
No	99.69 (99.68, 0.970)	99.55 (99.50, 99.59)	99.56 (99.50, 99.61)	99.31 (99.10, 99.47)

[+]Maternal weight is identified by reported maternal body mass index (BMI) in kg/m^2. Underweight is defined as <18.5 kg/m^2, Normal weight between 18.5-24.9 kg/m^2, Overweight between 25.0-29.9 kg/m^2, Obese between 35.0-39.9 kg/m^2, and Extremely Obese at ≥40.0 kg/m^2.

[++]The Appalachian Regional Commission Economic Classification system is an index-based classification system that categorizes counties based on their three-year average unemployment rates, poverty rates, and per capita market income. The classifications are attainment, competitive, transitional, at-risk, and distressed. Attainment and competitive classifications represent the most economically stable and account for the top 25% of the counties in the U.S. At-risk and distressed classifications represent the most economically weak counties and account for 25% of all counties in the U.S.

[+++]The day on which a woman gives birth has been implicated as a factor contributing to the variation in cesarean delivery rates. Consistent with previous literature (Haberman), weekdays are defined within the context of the "normal" work week (Monday-Friday) and weekends are Saturdays and Sundays.

[*] One-way Analysis of Variance (ANOVA) testing; $p<0.001$

Table 22

Adjusted Odds of Elective Cesarean Delivery by Urban Influence Code

Covariate	Odds Ratio	95% Confidence Interval
Environmental Characteristics		
Urban Influence Code		
Metropolitan	Ref	
Micropolitan	0.524	0.515, 0.533
Non-Core Adjacent	0.554	0.541, 0.568
Non-Core Non-Adjacent	0.418	0.394, 0.443
Year		
2016	Ref	
2017	0.916	0.904, 0.927
2018	0.869	0.858, 0.880
2019	0.776	0.766, 0.786
2020	0.752	0.742, 0.762
Health Professional Shortage Area Designations		
None Designation	Ref	
Parts Designation	1.315	1.293, 1.338
Whole Designation	1.334	1.298, 1.371
Predisposing Characteristics		
Maternal Age		
19 Years & Younger	Ref	
20-34 Years	1.152	1.132, 1.173
35 Years & Older	1.673	1.638, 1.708
Maternal Race/Ethnicity		
Non-Hispanic White	Ref	
Non-Hispanic Black	1.213	1.197, 1.228
Hispanic	1.454	1.438, 1.470
Non-Hispanic Other	1.214	1.198, 1.230
Maternal Educational Attainment		
Less than a High School Diploma	Ref	
High School Diploma or Equivalent	1.045	1.026, 1.063
Some College or Associate's Degree	1.017	0.999, 1.036
Advanced Degrees	1.078	1.058, 1.099
Maternal Weight		
Underweight	Ref	

Normal Weight	0.832	0.810, 0.854
Overweight	0.784	0.764, 0.806
Obese	0.777	0.756, 0.798
Extremely Obese	0.811	0.790, 0.835
Trimester Prenatal Care Began		
First Trimester	Ref	
Second Trimester	0.907	0.896, 0.918
Third Trimester	0.945	0.926, 0.965
No Prenatal Care	1.960	1.884, 2.039
Enabling Characteristics		
ARC Economic Classification		
Attainment	Ref	
Competitive	0.855	0.843, 0.867
Transitional	0.926	0.915, 0.937
At-risk	1.231	1.205, 1.257
Distressed	1.081	1.053, 1.110
Payment Method		
Private Insurance	Ref	
Medicaid	1.010	0.999, 1.021
Self-Pay	1.455	1.419, 1.493
Other	1.196	1.169, 1.223
Day of Birth		
Weekday	Ref	
Weekend	0.714	0.707, 0.721
Time of Birth		
0:00-4:00	Ref	
4:01-8:00	1.570	1.544, 1.598
8:01-12:00	2.665	2.624, 2.707
12:01-16:00	1.943	1.913, 1.973
16:01-20:00	1.248	1.229, 1.268
20:01-23:59	1.014	0.998, 1.030
Need Characteristics		
Smoking During Pregnancy		
Yes	0.741	0.724, 0.758
No	Ref	
Gestational Diabetes		
Yes	0.950	0.935, 0.965
No	Ref	
Hypertension		
Yes	0.695	0.686, 0.704

No	Ref	
Sexually Transmitted Infections		
Yes	0.721	0.701, 0.741
No	Ref	
Congenital Anomalies		
Yes	1.218	1.134, 1.307
No	Ref	

Table 23

Maternal Characteristics by Appalachian Designation among NTSV Pregnancies in the U.S. 2016-2020, Frequency (95% C.I.)

	Non-Appalachia (N=4,300,391)	**Southern Appalachia (N=118,151)**	**South Central Appalachia (N=62.046)**	**Central Appalachia (N=23.827)**	**North Central Appalachia (N=29,717)**	**Northern Appalachia (N=96,781)**
Environmental Characteristics						
*Health Professional Shortage Area Designations**						
None Designation	7.24 (7.21, 7.26)	10.21 (10.04, 10.39)	7.06 (6.86, 7.27)	13.12 (12.70, 13.55)	7.65 (7.35, 7.96)	6.21 (6.06, 6.37)
Parts Designation	88.76 (88.73, 88.79)	78.24 (78.01, 78.48)	89.65 (89.41, 89.89)	64.52 (63.91, 65.12)	84.82 (84.40, 85.22)	91.43 (91.25, 91.60)
Whole Designation	4.00 (3.98, 4.02)	11.54 (11.36, 11.73)	3.29 (3.15, 3.43)	22.36 (21.84, 22.89)	7.53 (7.24, 7.84)	2.36 (2.27, 2.46)
Predisposing Characteristics						
*Maternal Age**						
19 Years & Younger	11.58 (11.55, 11.61)	15.19 (14.98, 15.39)	16.07 (15.79, 16.36)	23.07 (22.54, 23.61)	17.53 (17.10, 17.97)	12.04 (11.84, 12.25)
20-34 Years	79.44 (79.40, 79.48)	79.29 (79.05, 79.52)	78.56 (78.23, 78.88)	74.31 (73.75, 74.86)	78.40 (77.93, 78.87)	81.48 (81.23, 81.72)
35 Years & Older	8.98 (8.96, 9.01)	5.53 (5.40, 5.66)	5.37 (5.19, 5.55)	2.61 (2.42, 2.83)	4.07 (3.85, 4.30)	6.48 (6.33, 6.64)
*Maternal Race/Ethnicity**						
Non-Hispanic White	52.07 (52.02, 52.12)	62.75 (62.47, 63.02)	81.25 (80.95, 81.56)	96.04 (95.79, 96.28)	92.35 (92.04, 92.64)	84.10 (83.87, 84.33)
Non-Hispanic Black	12.66 (12.63, 12.69)	19.94 (19.72, 20.17)	6.61 (6.42, 6.81)	1.05 (0.93, 1.19)	2.10 (1.94, 2.27)	6.02 (5.88, 6.18)
Hispanic	23.56 (23.52, 23.60)	11.53 (11.35, 11.71)	7.81 (7.60, 8.02)	1.38 (1.24, 1.54)	1.88 (1.73, 2.04)	4.39 (4.26, 4.52)
Non-Hispanic Other	11.71 (11.68, 11.74)	5.78 (5.65, 5.92)	4.33 (4.17, 4.49)	1.53 (1.38, 1.69)	3.68 (3.47, 3.90)	5.49 (5.34, 5.63)
*Maternal Educational Attainment**						
Less than a High School Diploma	9.86 (9.83, 9.88)	10.87 (10.70, 11.05)	10.28 (10.05, 10.53)	13.86 (13.43, 14.31)	11.94 (11.57, 12.31)	10.83 (10.64, 11.03)

High School Diploma or Equivalent	23.89 (23.85, 23.93)	29.52 (29.26, 29.78)	29.49 (29.14, 29.85)	36.46 (35.85, 37.07)	32.54 (32.01, 33.08)	26.04 (25.76, 26.32)
Some College or Associate's Degree	26.81 (26.77, 26.85)	28.78 (28.52, 29.04)	30.12 (29.76, 30.49)	32.85 (32.26, 33.45)	29.34 (28.83, 29.86)	25.89 (25.62, 26.17)
Advanced Degrees	39.45 (39.40, 39.49)	30.83 (30.57, 31.10)	30.10 (29.74, 30.46)	16.83 (16.36, 17.31)	26.18 (25.68, 26.68)	37.24 (36.93, 37.54)
Maternal Weight+*						
Underweight	4.11 (4.09, 4.13)	4.18 (4.06, 4.29)	4.74 (4.57, 4.91)	4.91 (4.64, 5.19)	4.25 (4.02, 4.49)	3.71 (3.59, 3.84)
Normal Weight	48.41 (48.36, 48.46)	43.12 (42.84, 43.41)	44.75 (44.35, 45.14)	37.90 (37.29, 38.53)	40.58 (40.02, 41.14)	45.17 (44.84, 45.51)
Overweight	25.14 (25.09, 25.18)	25.45 (25.20, 25.70)	24.14 (23.80, 24.49)	23.98 (23.44, 24.53)	24.47 (23.98, 24.96)	24.45 (24.17, 24.74)
Obese	18.33 (18.29, 18.37)	21.83 (21.60, 22.07)	20.88 (20.56, 21.21)	25.40 (24.85, 25.96)	23.80 (23.31, 24.29)	20.95 (20.68, 21.22)
Extremely Obese	4.01 (4.00, 4.03)	5.42 (5.29, 5.55)	5.49 (5.31, 5.67)	7.81 (7.47, 8.16)	6.91 (6.63, 7.21)	5.72 (5.56, 5.87)
*Trimester Prenatal Care Began**						
First Trimester	79.17 (79.13, 79.21)	77.11 (76.87, 77.35)	81.81 (81.49, 82.11)	83.37 (82.89, 83.84)	82.66 (82.22, 83.08)	83.31 (83.07, 83.55)
Second Trimester	14.99 (14.96, 15.03)	16.85 (16.63, 17.06)	13.81 (13.53, 14.09)	12.85 (12.43, 13.29)	12.99 (12.61, 13.38)	12.74 (12.53, 12.95)
Third Trimester	4.52 (4.50, 4.54)	4.18 (4.07, 4.30)	3.58 (3.43, 3.73)	3.24 (3.02, 3.48)	3.75 (3.54, 3.97)	3.44 (3.33, 3.56)
No Prenatal Care	1.32 (1.30, 1.33)	1.87 (1.79, 1.95)	0.81 (0.74, 0.88)	0.54 (0.45, 0.64)	0.60 (0.52, 0.70)	0.51 (0.47, 0.56)
Enabling Characteristics						
ARC Economic Classification++*						
Attainment	17.52 (17.48, 17.56)	4.73 (4.61, 4.86)	0.10 (0.08, 0.13)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)
Competitive	19.58 (19.54, 19.61)	2.93 (2.84, 3.03)	0.63 (0.57, 0.69)	0.00 (0.00, 0.00)	11.20 (10.85, 11.56)	23.04 (22.78, 23.31)
Transitional	55.05 (55.00, 55.10)	78.54 (78.30, 78.77)	85.34 (85.05, 85.62)	14.27 (13.83, 14.72)	50.59 (50.02, 51.16)	71.81 (71.52, 72.09)
At-risk	5.05 (5.03, 5.07)	12.70 (12.51, 12.89)	12.42 (12.16, 12.69)	32.17 (31.58, 32.77)	27.65 (27.15, 28.16)	5.12 (4.98, 5.26)
Distressed	2.80 (2.79, 2.82)	1.10 (1.05, 1.16)	1.52 (1.42, 1.62)	53.56 (52.93, 54.19)	10.56 (10.22, 10.92)	0.03 (0.02, 0.05)
*Payment Method**						
Private Insurance	56.57 (56.52, 56.62)	51.77 (51.49, 52.06)	51.16 (50.76, 51.55)	38.04 (37.43, 38.66)	55.26 (54.69, 55.82)	63.82 (63.51, 64.13)
Medicaid	35.94 (35.90, 35.99)	41.79 (41.51, 42.07)	46.05 (45.65, 46.44)	57.97 (57.34, 58.60)	40.86 (40.30, 41.42)	30.83 (30.54, 31.13)
Self-Pay	3.50 (3.48, 3.51)	3.87 (3.76, 3.98)	1.87 (1.76, 1.98)	1.78 (1.62, 1.95)	1.94 (1.79, 2.10)	2.99 (2.89, 3.11)
Other	3.99 (3.97, 4.01)	2.57 (2.48, 2.66)	0.93 (0.86, 1.01)	2.21 (2.03, 2.41)	1.94 (1.79, 2.10)	2.35 (2.26, 2.45)
Day of Birth+++*						
Weekday	76.25 (76.21, 76.29)	80.88 (80.65, 81.10)	79.18 (78.86, 79.50)	82.65 (82.16, 83.13)	79.39 (78.93, 79.85)	77.05 (76.78, 77.31)
Weekend	23.75 (23.71, 23.79)	19.12 (18.90, 19.35)	20.82 (20.50, 21.14)	17.35 (16.87, 17.84)	20.61 (20.15, 21.07)	22.95 (22.69, 23.22)
*Time of Birth**						
0:00-4:00	13.68 (13.65, 13.71)	10.76 (10.58, 10.94)	12.75 (12.49, 13.02)	10.76 (10.37, 11.16)	15.38 (14.98, 15.80)	13.48 (13.27, 13.70)
4:01-8:00	12.77 (12.74, 12.80)	10.36 (10.18, 10.53)	11.62 (11.37, 11.87)	10.09 (9.718, 10.48)	16.51 (16.09, 16.94)	12.37 (12.16, 12.57)
8:01-12:00	16.50 (16.46, 16.53)	15.64 (15.44, 15.85)	15.60 (15.32, 15.89)	16.04 (15.58, 16.52)	20.15 (19.70, 20.61)	16.58 (16.35, 16.82)
12:01-16:00	19.30 (19.27, 19.34)	22.57 (22.33, 22.81)	19.90 (19.59, 20.22)	22.56 (22.04, 23.10)	18.38 (17.94, 18.83)	19.29 (19.04, 19.54)
16:01-20:00	20.16 (20.12, 20.20)	23.66 (23.42, 23.91)	21.66 (21.34, 21.99)	23.67 (23.14, 24.22)	16.45 (16.04, 16.88)	20.36 (20.10, 20.61)
20:01-23:59	17.59 (17.56, 17.63)	17.01 (16.80, 17.23)	18.46 (18.16, 18.77)	16.87 (16.40, 17.35)	13.12 (12.74, 13.51)	17.93 (17.69, 18.17)
Need Characteristics						
*Smoking During Pregnancy**						
Yes	3.62 (3.61, 3.64)	5.42 (5.29, 5.55)	10.41 (10.17, 10.66)	16.58 (16.11, 17.05)	14.99 (14.59, 15.41)	11.33 (11.13, 11.53)
No	96.38 (96.36, 96.40)	94.58 (94.45, 94.71)	89.59 (89.34, 89.83)	83.42 (82.95, 83.89)	85.01 (84.59, 85.41)	88.67 (88.47, 88.87)
*Gestational Diabetes**						
Yes	5.36 (5.34, 5.38)	4.50 (4.39, 4.62)	5.97 (5.79, 6.16)	6.89 (6.58, 7.22)	5.81 (5.55, 6.08)	5.70 (5.56, 5.85)
No	94.64 (94.62, 94.66)	95.50 (95.38, 95.61)	94.03 (93.84, 94.21)	93.11 (92.78, 93.42)	94.19 (93.92, 94.45)	94.30 (94.15, 94.44)

Hypertension[*]						
Yes	9.52 (9.49, 9.54)	10.79 (10.61, 10.97)	11.33 (11.08, 11.58)	15.01 (14.56, 15.47)	14.53 (14.14, 14.94)	9.11 (8.93, 9.29)
No	90.48 (90.46, 90.51)	89.21 (89.03, 89.39)	88.67 (88.42, 88.92)	84.99 (84.53, 85.44)	85.47 (85.06, 85.86)	90.89 (90.71, 91.07)
Sexually Transmitted Infections[*]						
Yes	2.80 (2.78, 2.81)	3.05 (2.95, 3.15)	3.91 (3.76, 4.06)	3.89 (3.65, 4.15)	3.88 (3.67, 4.11)	3.10 (2.99, 3.21)
No	97.20 (97.19, 97.22)	96.95 (96.85, 97.05)	96.09 (95.94, 96.24)	96.11 (95.86, 96.35)	96.12 (95.89, 96.33)	96.90 (96.79, 97.01)
Congenital Anomalies[*]						
Yes	0.23 (0.22, 0.23)	0.16 (0.14, 0.19)	0.23 (0.19, 0.27)	0.40 (0.32, 0.49)	0.47 (0.40, 0.55)	0.33 (0.30, 0.37)
No	99.77 (99.76, 99.78)	99.84 (99.81, 99.86)	99.77 (99.73, 99.81)	99.60 (99.52, 99.68)	99.53 (99.45, 99.60)	99.67 (99.63, 99.70)

[+]Maternal weight is identified by reported maternal body mass index (BMI) in kg/m^2. Underweight is defined as <18.5 kg/m^2, Normal weight between 18.5-24.9 kg/m^2, Overweight between 25.0-29.9 kg/m^2, Obese between 35.0-39.9 kg/m^2, and Extremely Obese at ≥40.0 kg/m^2.

[++]The Appalachian Regional Commission Economic Classification system is an index-based classification system that categorizes counties based on their three-year average unemployment rates, poverty rates, and per capita market income. The classifications are attainment, competitive, transitional, at-risk, and distressed. Attainment and competitive classifications represent the most economically stable and account for the top 25% of the counties in the U.S. At-risk and distressed classifications represent the most economically weak counties and account for 25% of all counties in the U.S.

[+++]The day on which a woman gives birth has been implicated as a factor contributing to the variation in cesarean delivery rates. Consistent with previous literature (Haberman), weekdays are defined within the context of the "normal" work week (Monday-Friday) and weekends are Saturdays and Sundays.

[*] One-way Analysis of Variance (ANOVA) testing; p<0.001

Table 24

Adjusted Odds of NTSV Cesarean Delivery by Appalachian Designation

Covariate	Odds Ratio	95% Confidence Interval
Environmental Characteristics		
Appalachian Designation		
Non-Appalachia	Ref	
Southern Appalachia	1.066	1.051, 1.081
South Central Appalachia	0.976	0.957, 0.996
Central Appalachia	1.084	1.050, 1.118
North Central Appalachia	1.038	1.010, 1.068
Northern Appalachia	1.047	1.030, 1.065
Year		
2016	Ref	
2017	0.996	0.989, 1.003
2018	0.965	0.958, 0.972
2019	0.937	0.931, 0.944
2020	0.929	0.922, 0.935

Health Professional Shortage Area Designations[*]		
None Designation	Ref	
Parts Designation	0.983	0.974, 0.992
Whole Designation	0.977	0.963, 0.991
Predisposing Characteristics		
Maternal Age		
19 Years & Younger	Ref	
20-34 Years	1.587	1.573, 1.602
35 Years & Older	3.185	3.149, 3.222
Maternal Race/Ethnicity		
Non-Hispanic White	Ref	
Non-Hispanic Black	1.378	1.368, 1.388
Hispanic	1.151	1.144, 1.159
Non-Hispanic Other	1.229	1.220, 1.238
Maternal Educational Attainment		
Less than a High School Diploma	Ref	
High School Diploma or Equivalent	1.011	1.002, 1.021
Some College or Associate’s Degree	1.040	1.030, 1.050
Advanced Degrees	1.094	1.083, 1.106
Maternal Weight		
Underweight	Ref	
Normal Weight	1.315	1.297, 1.333
Overweight	1.909	1.883, 1.936
Obese	2.722	2.683, 2.760
Extremely Obese	4.539	4.466, 4.615
Trimester Prenatal Care Began		
First Trimester	Ref	
Second Trimester	0.987	0.981, 0.994
Third Trimester	0.963	0.952, 0.974
No Prenatal Care	0.907	0.887, 0.926
Enabling Characteristics		
ARC Economic Classification		
Attainment	Ref	
Competitive	0.995	0.987, 1.003
Transitional	1.034	1.027, 1.041
At-risk	1.103	1.090, 1.116
Distressed	1.139	1.123, 1.156
Payment Method		
Private Insurance	Ref	

Medicaid	0.980	0.974, 0.986
Self-Pay	0.803	0.792, 0.814
Other	0.865	0.855, 0.876
Day of Birth		
Weekday	Ref	
Weekend	0.829	0.824, 0.833
Time of Birth		
0:00-4:00	Ref	
4:01-8:00	1.051	1.042, 1.061
8:01-12:00	1.369	1.357, 1.380
12:01-16:00	1.139	1.130, 1.149
16:01-20:00	1.189	1.179, 1.198
20:01-23:59	1.270	1.259, 1.280
Need Characteristics		
Smoking During Pregnancy		
Yes	1.141	1.128, 1.154
No	Ref	
Gestational Diabetes		
Yes	1.280	1.268, 1.292
No	Ref	
Hypertension		
Yes	1.436	1.426, 1.446
No	Ref	
Sexually Transmitted Infections		
Yes	0.934	0.921, 0.948
No	Ref	
Congenital Anomalies		
Yes	1.612	1.544, 1.682
No	Ref	

Table 25

Maternal Characteristics by Appalachian Designation among Women who had an Elective Cesarean Delivery 2016-2020, Frequency (95% C.I.)

	Non-Appalachia (N=1,054,662)	Southern Appalachia (N=30,728)	South Central Appalachia (N=14,795)	Central Appalachia (N=6,414)	North Central Appalachia (N=7,475)	Northern Appalachia (N=26,641)
Environmental Characteristics						
Health Professional Shortage Area Designations[*]						
None Designation	7.26 (7.21, 7.31)	10.71 (10.37, 11.06)	7.52 (7.11, 7.96)	12.94 (12.14, 13.78)	7.22 (6.66, 7.83)	5.60 (5.31, 5.89)
Parts Designation	88.74 (88.68, 88.80)	77.01 (76.54, 77.48)	89.23 (88.72, 89.72)	65.25 (64.07, 66.40)	85.58 (84.76, 86.36)	92.40 (92.07, 92.73)
Whole Designation	4.00 (3.96, 4.04)	12.28 (11.92, 12.65)	3.24 (2.97, 3.54)	21.81 (20.82, 22.84)	7.20 (6.63, 7.81)	2.01 (1.84, 2.19)
Predisposing Characteristics						
Maternal Age[*]						
19 Years & Younger	7.43 (7.38, 7.48)	10.08 (9.750, 10.42)	10.62 (10.13, 11.13)	16.54 (15.65, 17.47)	12.45 (11.73, 13.22)	8.10 (7.77, 8.45)
20-34 Years	78.39 (78.31, 78.47)	80.61 (80.17, 81.05)	80.28 (79.63, 80.92)	78.61 (77.59, 79.60)	80.82 (79.91, 81.69)	81.61 (81.12, 82.09)
35 Years & Older	14.18 (14.12, 14.25)	9.30 (8.98, 9.63)	9.10 (8.65, 9.57)	4.85 (4.35, 5.40)	6.73 (6.18, 7.32)	10.28 (9.911, 10.67)
Maternal Race/Ethnicity[*]						
Non-Hispanic White	50.00 (49.91, 50.10)	61.87 (61.32, 62.41)	81.05 (80.41, 81.67)	95.25 (94.70, 95.75)	92.36 (91.73, 92.94)	83.18 (82.71, 83.64)
Non-Hispanic Black	14.95 (14.88, 15.02)	22.76 (22.29, 23.23)	7.64 (7.22, 8.08)	1.30 (1.05, 1.61)	2.27 (1.95, 2.63)	6.61 (6.31, 6.93)
Hispanic	22.99 (22.91, 23.08)	9.43 (9.11, 9.76)	6.79 (6.39, 7.21)	1.61 (1.33, 1.95)	1.89 (1.61, 2.23)	4.34 (4.09, 4.60)
Non-Hispanic Other	12.05 (11.99, 12.12)	5.94 (5.68, 6.21)	4.52 (4.20, 4.87)	1.84 (1.54, 2.20)	3.49 (3.09, 3.93)	5.87 (5.58, 6.17)
Maternal Educational Attainment[*]						
Less than a High School Diploma	7.83 (7.78, 7.88)	8.65 (8.34, 8.97)	8.12 (7.69, 8.57)	10.75 (10.02, 11.54)	9.52 (8.87, 10.21)	7.55 (7.23, 7.89)
High School Diploma or Equivalent	22.89 (22.81, 22.98)	28.19 (27.69, 28.69)	28.19 (27.47, 28.92)	36.41 (35.24, 37.60)	31.29 (30.25, 32.35)	25.47 (24.93, 26.02)
Some College or Associate's Degree	28.09 (28.00, 28.17)	30.01 (29.50, 30.53)	32.55 (31.80, 33.31)	34.61 (33.45, 35.78)	31.88 (30.83, 32.95)	28.09 (27.53, 28.66)
Advanced Degrees	41.20 (41.11, 41.29)	33.15 (32.63, 33.68)	31.14 (30.40, 31.89)	18.23 (17.30, 19.20)	27.31 (26.31, 28.33)	38.88 (38.27, 39.49)
Maternal Weight[+*]						
Underweight	2.46 (2.43, 2.49)	2.30 (2.14, 2.48)	2.65 (2.40, 2.92)	2.78 (2.40, 3.21)	2.65 (2.30, 3.04)	2.01 (1.83, 2.20)
Normal Weight	37.84 (37.75, 37.94)	31.21 (30.69, 31.73)	32.98 (32.22, 33.75)	25.79 (24.73, 26.88)	28.29 (27.27, 29.32)	32.90 (32.28, 33.53)
Overweight	26.62 (26.53, 26.70)	25.71 (25.22, 26.20)	24.18 (23.49, 24.88)	23.27 (22.25, 24.33)	24.01 (23.05, 24.99)	25.48 (24.91, 26.06)
Obese	25.31 (25.22, 25.39)	30.19 (29.67, 30.71)	29.25 (28.51, 29.99)	33.44 (32.29, 34.61)	31.73 (30.68, 32.80)	28.51 (27.92, 29.11)
Extremely Obese	7.77 (7.72, 7.82)	10.60 (10.25, 10.95)	10.95 (10.45, 11.47)	14.72 (13.87, 15.62)	13.33 (12.58, 14.13)	11.10 (10.69, 11.52)
Trimester Prenatal Care Began[*]						

First Trimester	80.40 (80.32, 80.47)	79.00 (78.54, 79.45)	82.76 (82.13, 83.37)	83.57 (82.63, 84.46)	83.82 (82.96, 84.63)	85.02 (84.56, 85.47)
Second Trimester	14.26 (14.19, 14.32)	15.94 (15.54, 16.36)	13.33 (12.79, 13.90)	12.97 (12.16, 13.82)	12.46 (11.73, 13.23)	11.37 (10.98, 11.78)
Third Trimester	4.226 (4.187, 4.265)	3.60 (3.40, 3.82)	3.22 (2.95, 3.53)	3.02 (2.62, 3.47)	3.17 (2.80, 3.60)	3.21 (2.99, 3.44)
No Prenatal Care	1.12 (1.10, 1.14)	1.46 (1.33, 1.60)	0.68 (0.56, 0.83)	0.45 (0.31, 0.64)	0.55 (0.41, 0.75)	0.40 (0.33, 0.49)
Enabling Characteristics						
ARC Economic Classification[++*]						
Attainment	17.51 (17.44, 17.58)	5.11 (4.87, 5.37)	0.08 (0.05, 0.15)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)
Competitive	18.97 (18.89, 19.04)	3.36 (3.17, 3.57)	0.58 (0.47, 0.72)	0.00 (0.00, 0.00))	11.41 (10.71, 12.15)	23.30 (22.77, 23.83)
Transitional	55.22 (55.13, 55.32)	76.78 (76.30, 77.25)	84.61 (84.02, 85.19)	14.74 (13.89, 15.63)	52.03 (50.89, 53.16)	71.60 (71.03, 72.16)
At-risk	5.27 (5.22, 5.31)	13.46 (13.08, 13.84)	13.23 (12.69, 13.79)	31.45 (30.32, 32.60)	26.05 (25.06, 27.05)	5.07 (4.81, 5.35)
Distressed	3.03 (3.00, 3.06)	1.29 (1.17, 1.42)	1.49 (1.31, 1.70)	53.81 (52.59, 55.03)	10.52 (9.840, 11.23)	0.03 (0.01, 0.06)
Payment Method[*]						
Private Insurance	59.17 (59.07, 59.26)	55.37 (54.81, 55.92)	53.75 (52.94, 54.55)	40.17 (38.97, 41.38)	56.77 (55.65, 57.90)	66.23 (65.63, 66.83)
Medicaid	34.61 (34.52, 34.70)	39.24 (38.70, 39.79)	44.17 (43.37, 44.98)	56.56 (55.34, 57.78)	40.37 (39.26, 41.48)	30.36 (29.78, 30.95)
Self-Pay	2.76 (2.73, 2.79)	2.88 (2.70, 3.07)	1.12 (0.96, 1.31)	1.12 (0.89, 1.41)	1.22 (1.00, 1.50)	1.39 (1.25, 1.55)
Other	3.46 (3.43, 3.50)	2.51 (2.34, 2.70)	0.96 (0.81, 1.13)	2.15 (1.82, 2.54)	1.64 (1.37, 1.95)	2.01 (1.84, 2.20)
Day of Birth[+++*]						
Weekday	78.95 (78.87, 79.03)	83.93 (83.52, 84.34)	81.00 (80.36, 81.62)	85.67 (84.79, 86.51)	82.64 (81.76, 83.48)	79.44 (78.93, 79.94)
Weekend	21.05 (20.97, 21.13)	16.07 (15.66, 16.48)	19.00 (18.38, 19.64)	14.33 (13.49, 15.21)	17.36 (16.52, 18.24)	20.56 (20.06, 21.07)
Time of Birth[*]						
0:00-4:00	12.06 (11.99, 12.12)	9.07 (8.75, 9.40)	11.54 (11.03, 12.06)	8.609 (7.947, 9.321)	12.72 (11.98, 13.49)	11.75 (11.35, 12.15)
4:01-8:00	11.51 (11.44, 11.57)	10.62 (10.28, 10.97)	11.40 (10.90, 11.93)	9.22 (8.53, 9.95)	15.42 (14.62, 16.26)	10.78 (10.40, 11.17)
8:01-12:00	18.35 (18.28, 18.43)	16.39 (15.98, 16.80)	18.05 (17.44, 18.68)	19.87 (18.91, 20.86)	22.96 (22.02, 23.93)	18.63 (18.15, 19.12)
12:01-16:00	18.93 (18.86, 19.01)	19.54 (19.10, 19.99)	17.47 (16.87, 18.09)	18.90 (17.96, 19.88)	16.99 (16.15, 17.86)	18.62 (18.14, 19.11)
16:01-20:00	20.43 (20.35, 20.50)	25.18 (24.70, 25.67)	21.26 (20.61, 21.93)	23.53 (22.51, 24.59)	17.22 (16.38, 18.09)	20.56 (20.06, 21.07)
20:01-23:59	18.72 (18.65, 18.80)	19.21 (18.77, 19.66)	20.27 (19.63, 20.93)	19.87 (18.91, 20.86)	14.70 (13.91, 15.52)	19.66 (19.17, 20.16)
Need Characteristics						
Smoking During Pregnancy[*]						
Yes	3.78 (3.74, 3.82)	5.66 (5.41, 5.92)	10.77 (10.28, 11.28)	17.26 (16.35, 18.21)	15.50 (14.69, 16.34)	11.71 (11.32, 12.12)
No	96.22 (96.19, 96.26)	94.34 (94.08, 94.59)	89.23 (88.72, 89.72)	82.74 (81.79, 83.65)	84.50 (83.66, 85.31)	88.29 (87.88, 88.68)
Gestational Diabetes[*]						
Yes	7.59 (7.54, 7.64)	6.57 (6.30, 6.86)	8.22 (7.79, 8.67)	10.06 (9.344, 10.82)	8.78 (8.16, 9.44)	8.26 (7.92, 8.61)
No	92.41 (92.36, 92.46)	93.43 (93.14, 93.70)	91.78 (91.33, 92.21)	89.94 (89.18, 90.66)	91.22 (90.56, 91.84)	91.75 (91.40, 92.08)
Hypertension[*]						
Yes	13.75 (13.68, 13.81)	16.41 (16.00, 16.82)	16.53 (15.94, 17.13)	21.48 (20.50, 22.51)	20.23 (19.33, 21.15)	13.56 (13.14, 14.00)
No	86.25 (86.19, 86.32)	83.59 (83.18, 84.00)	83.47 (82.87, 84.06)	78.52 (77.49, 79.50)	79.77 (78.85, 80.67)	86.44 (86.00, 86.86)
Sexually Transmitted Infections[*]						
Yes	2.50 (2.47, 2.53)	2.63 (2.46, 2.82)	3.67 (3.38, 3.99)	3.88 (3.43, 4.38)	3.74 (3.33, 4.20)	2.92 (2.72, 3.14)
No	97.50 (97.47, 97.53)	97.37 (97.19, 97.54)	96.33 (96.01, 96.62)	96.12 (95.62, 96.57)	96.26 (95.80, 96.67)	97.08 (96.86, 97.28)
Congenital Anomalies[*]						
Yes	0.32 (0.31, 0.33)	0.22 (0.18, 0.28)	0.38 (0.29, 0.49)	0.56 (0.41, 0.78)	0.74 (0.57, 0.96)	0.47 (0.39, 0.56)
No	99.68 (99.67, 99.69)	99.78 (99.72, 99.83)	99.62 (99.51, 99.71)	99.44 (99.22, 99.59)	99.26 (99.04, 99.43)	99.53 (99.44, 99.61)

[+]Maternal weight is identified by reported maternal body mass index (BMI) in kg/m^2. Underweight is defined as <18.5 kg/m^2, Normal weight between 18.5-24.9 kg/m^2, Overweight between 25.0-29.9 kg/m^2, Obese between 35.0-39.9 kg/m^2, and Extremely Obese at ≥40.0 kg/m^2.

[++]The Appalachian Regional Commission Economic Classification system is an index-based classification system that categorizes counties based on their three-year average unemployment rates, poverty rates, and per capita market income. The classifications are attainment, competitive, transitional, at-risk, and distressed. Attainment and competitive classifications represent the most economically stable and account for the top 25% of the counties in the U.S. At-risk and distressed classifications represent the most economically weak counties and account for 25% of all counties in the U.S.
[+++]The day on which a woman gives birth has been implicated as a factor contributing to the variation in cesarean delivery rates. Consistent with previous literature (Haberman), weekdays are defined within the context of the "normal" work week (Monday-Friday) and weekends are Saturdays and Sundays.
[*] One-way Analysis of Variance (ANOVA) testing; $p<0.001$

Table 26

Adjusted Odds of Elective Cesarean Delivery by Appalachian Designation

Covariate	Odds Ratio	95% Confidence Interval
Environmental Characteristics		
Appalachian Designation		
Non-Appalachia	Ref	
Southern Appalachia	1.044	1.019, 1.071
South Central Appalachia	0.676	0.650, 0.704
Central Appalachia	0.700	0.658, 0.745
North Central Appalachia	0.622	0.589, 0.658
Northern Appalachia	0.520	0.502, 0.538
Year		
2016	Ref	
2017	0.917	0.905, 0.928
2018	0.870	0.856, 0.881
2019	0.777	0.767, 0.787
2020	0.753	0.744, 0.763
Health Professional Shortage Area Designations[*]		
None Designation	Ref	
Parts Designation	1.381	1.358, 1.405
Whole Designation	1.103	1.074, 1.133
Predisposing Characteristics		
Maternal Age		
19 Years & Younger	Ref	

20-34 Years	1.173	1.153, 1.194
35 Years & Older	1.720	1.685, 1.756
Maternal Race/Ethnicity		
Non-Hispanic White	Ref	
Non-Hispanic Black	1.259	1.243, 1.275
Hispanic	1.517	1.500, 1.533
Non-Hispanic Other	1.234	1.218, 1.251
Maternal Educational Attainment		
Less than a High School Diploma	Ref	
High School Diploma or Equivalent	1.047	1.028, 1.065
Some College or Associate's Degree	1.020	1.002, 1.039
Advanced Degrees	1.103	1.082, 1.124
Maternal Weight		
Underweight	Ref	
Normal Weight	0.828	0.807, 0.851
Overweight	0.778	0.758, 0.800
Obese	0.766	0.746, 0.787
Extremely Obese	0.794	0.771, 0.818
Trimester Prenatal Care Began		
First Trimester	Ref	
Second Trimester	0.908	0.897, 0.919
Third Trimester	0.949	0.929, 0.969
No Prenatal Care	1.996	1.919, 2.077
Enabling Characteristics		
ARC Economic Classification		
Attainment	Ref	
Competitive	0.853	0.841, 0.865
Transitional	0.910	0.899, 0.921
At-risk	1.048	1.027, 1.070
Distressed	0.901	0.878, 0.925
Payment Method		
Private Insurance	Ref	
Medicaid	1.002	0.991, 1.012
Self-Pay	1.431	1.395, 1.468
Other	1.183	1.156, 1.210
Day of Birth		
Weekday	Ref	
Weekend	0.719	0.712, 0.726
Time of Birth		
0:00-4:00	Ref	

4:01-8:00	1.563	1.536, 1.590
8:01-12:00	2.653	2.612, 2.694
12:01-16:00	1.931	1.901, 1.961
16:01-20:00	1.237	1.218, 1.256
20:01-23:59	1.010	0.994, 1.026
Need Characteristics		
Smoking During Pregnancy		
Yes	0.720	0.704, 0.737
No	Ref	
Gestational Diabetes		
Yes	0.953	0.938, 0.968
No	Ref	
Hypertension		
Yes	0.692	0.683, 0.701
No	Ref	
Sexually Transmitted Infections		
Yes	0.719	0.699, 0.739
No	Ref	
Congenital Anomalies		
Yes	1.208	1.126, 1.297
No	Ref	

Appendix B: Field-Based Product - Manuscript

Variations in Elective Cesarean Deliveries in Appalachia relative to Non-Appalachia, 2016-2020

Introduction

Of the approximately 3.7 infants born in the United States (U.S.) in 2019, nearly one in three were born via cesarean delivery (Martin et al., 2021). Cesarean delivery, when medically indicated, can be a life-saving procedure; however, when there is no indication of medical need, it can present substantial risk to the short and long-term health of the mother and infant (Sandall et al., 2018). Cesarean deliveries also influence and dictate subsequent labors and deliveries, leading to higher risk for maternal morbidity and mortality (Matevosyan, 2015; Osterman & Martin, 2014; Sandall et al., 2018). Further, cesarean deliveries have significant impact on health care quality and health care costs, making the reduction of non-medically indicated cesarean deliveries an important public health issue.

In the U.S., cesarean sections are the most commonly performed major surgery (Boyle & Reddy, 2012). The rate of cesarean deliveries has increased dramatically in the U.S. over the last several decades from 14.5% in 1996 to 31.7% in 2019 (Boyle & Reddy, 2012; Martin et al., 2021). Similarly, the rate of non-medically indicated, or low-risk, cesarean deliveries has increased from 18.4% in the late 1990s to 26.9% in the mid 2010s (Osterman & Martin, 2014b). Increases in cesarean deliveries were seen across all demographic groups (Boyle & Reddy, 2012). A wide variety of non-clinical factors are associated with the rates of non-medically indicated cesarean deliveries including patient characteristics, socioeconomic resources, provider and health system characteristics are major drivers in the variations in cesarean delivery rates (Haberman et al., 2013; Janakiraman et al., 2011; Kaimal & Kuppermann, 2012; Roth & Henley, 2014). Socioeconomic status is also been implicated as an independent predictor of variation in cesarean delivery, with women of lower socioeconomic status being at a lower odds for cesarean delivery compared to women of higher socioeconomic status (Milcent & Zbiri, 2018). A growing explanation for the increasing rates of cesarean deliveries are non-medically indicated and elective cesarean deliveries (Yamamoto, 2011).

Appalachia, a predominantly rural region, is disproportionately burdened by persistent poverty, poor health outcomes, and lack of access to affordable health care and services (Hale et al., 2022). Health disparities, including women's health outcomes, within the Appalachian region, are well documented (Marshall et al., 2017; G. K. Singh et al., 2017). However, there is a paucity of research on the variations in cesarean deliveries in this region. As such, the purpose of this study is to determine the extent to which the variations in elective cesarean deliveries in the Appalachian sub-regions mirrored national trends. It is hypothesized that the rates of elective cesarean deliveries in the U.S. would be significantly lower among women in non-Appalachia compared to the Appalachian sub-regions. This hypothesis is based on the existing literature which suggests that rural, low-resource hospitals have lower rates of non-medically indicated cesarean deliveries compared to urban hospitals (Kozhimannil, Hung, et al., 2014a). Further, it is hypothesized that the rates of elective cesarean deliveries would be highest in Northern Appalachia, a substantially metropolitan region with higher levels of health resources, and lowest in Central Appalachia, a region with the highest levels of economic distress and health professional shortages (Hale et al., 2022).

Methods

Study Design

We conducted a retrospective repeated cross-sectional analysis of vital records data from the National Center for Health Statistics (NHCS). Due to the nature of the data, publicly available and de-identified, this research was deemed non-human subjects research.

Data Sources

Birth records data obtained from the NCHS National Vital Statistics System (NVSS) for the years 2016 to 2020 was used for this study. Consistent with previous literature on health outcomes in this region (Hale et al., 2022; Meit et al., 2017b), data on county-level economic status was obtained from the Appalachian Regional Commission (ARC). Additionally, data on the availability of health care resources at the county-level was abstracted from the Area Health Resource File (AHRF).

Study Population

Data on nulliparous, term, singleton, vertex (NTSV) cesarean births to reproductive aged women in the U.S. between 2016 and 2020 was collected. Births to females less than 15 years and greater than 44 years were excluded because they fall outside of the standard metric of reproductive age as established by the American College of Obstetrics and Gynecology.

Dependent Variable

Elective cesarean delivery among low-risk pregnancies was the primary outcome of interest. Low-risk pregnancy is defined as a pregnancy with a nulliparous mother at term with a singleton infant in vertex position. Elective cesarean deliveries area defined as cesarean deliveries in which no trial of labor was reported. Elective cesarean delivery was dichotomized as 0: non-elective or 1: elective.

Independent Variable

Appalachia and the sub-regions of Appalachia are of primary interest in this study. Consistent with recent research on variations in women's health outcomes in this region (Hale et al., 2022), Appalachian designation serves as the primary predictor of this study. The ARC divides the Appalachian region into five distinct sub-regions including Southern, South Central, Central, North Central, and Northern. We created a six-level categorical variable for Appalachian designation using the mother's county FIPS codes to organize observations into their respective sub-region or non-Appalachia. Non-Appalachia serves as the reference group in the analyses.

Covariates of Interest

Variable selection was based on the Andersen Healthcare Utilization Model, a well-known and widely applied model that integrates individual and broader contextual factors to explain health seeking behaviors (Andersen, 1995). This model purposes that the use of health care services is “a function of individuals and families predisposition to use services, factors which enable or impede use, and the need for care” (Andersen, 1995). Influential predisposing, enabling, and need characteristics were identified from the existing body of scholarly literature and included in the analysis. Predisposing characteristics included maternal age, race/ethnicity, educational attainment, body mass index, and the trimester in which prenatal care began. Enabling characteristics included are the Area Health Resource File Health Professional Shortage Area designations, the ARC economic classification designations, insurance type, and timing of delivery. In order to account for socioeconomic status, a factor which is not measured on birth certificates, the ARC economic classification system was utilized. This metric has been utilized in recent studies examining the variations in health outcomes in Appalachia relative to non-Appalachia (Hale et al., 2022; Meit et al., 2017b). The ARC economic classification is a composite measure of economic stability calculated using the three-year averages of poverty rate, unemployment rate, and per capita income (Meit et al., 2017b). Counties are classified as attainment, competitive, transitional, at-risk, and distressed (Meit et al., 2017b). The top 25% of counties are classified as attainment and competitive, whereas the bottom 25% are defined as at-risk or distressed (Meit et al., 2017b). Need characteristics included the presence of common medical indications for cesarean delivery (smoking during pregnancy, gestational diabetes, hypertension, sexually transmitted infections, and congenital anomalies).

Statistical Analysis

One-way analysis of variance (ANOVA) was utilized to examine the differences in the characteristics of NTSV women who had an elective cesarean delivery by Appalachian designation. Frequency of elective cesarean deliveries by year and Appalachian sub-regions were calculated, and Chi-square tests were utilized to determine if there were significant differences in rates over time. Unadjusted logistic regression models were used to estimate the association between elective cesarean delivery and Appalachian designation. Multi-variable logistic regression analysis was used to estimate the likelihood of having elective cesarean delivery in relation to the mother's region of residence while adjusting for potential confounders. Results are presented as odds ratios and 95% confidence intervals. Marginal analyses, based on the adjusted logistic regression, was conducted to calculate the adjusted prevalence of elective cesarean deliveries by year and sub-region. We performed all data management and analyses using STATA version 15 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC.)

Results

Tables appear in Chapter 4 and Appendix A. Between 2016 and 2020 there were 4,646,343 NTSV births of which 37.2% (N=1,138,743) were elective cesarean sections. Table 25 shows the characteristics of births in the U.S. between 2016 and 2020. Compared to Appalachian women, non-Appalachian women were more ethnically diverse, had lower proportions of whole health professional shortages, of obesity and extreme obesity, Medicaid utilization, and common indications of medical need. When examining the characteristics of births within the Appalachian sub-regions, births in Central Appalachia had the highest rates of whole health professional shortages, the highest rates of obesity and extreme obesity, economic distress, Medicaid utilization, and highest rates of medical indications of need. Conversely, Northern Appalachia had the had lower proportions of whole health professional shortages, of obesity and extreme obesity, Medicaid utilization, and common indications of medical need.

The unadjusted prevalence of elective cesarean deliveries is shown in Table 15 and the unadjusted odds ratios of elective cesarean delivery by Appalachian designation is shown in Table 16. Significant differences in the unadjusted odds of elective cesarean deliveries were noted across the Appalachian sub-regions and non-Appalachia. Relative to women in non-Appalachia, women in Appalachia had significantly lower unadjusted rates of elective cesarean deliveries compared to women in non-Appalachia. Southern Appalachia had the highest unadjusted prevalence of elective cesarean sections compared to the other Appalachian sub-regions across the study period. Conversely, Central and North Central Appalachia had the lowest unadjusted rates of elective cesarean deliveries relative to the other sub-regions and non-Appalachia.

Relative to women in non-Appalachia, women in all of the Appalachian sub-regions were at a significantly lower odds of having an elective cesarean delivery. In particular, women in North Central Appalachia had the highest difference in the unadjusted odds of having an elective cesarean delivery (OR=0.52, 95% C.I. 0.50-0.55) compared to non-Appalachia, whereas Southern Appalachia had the lowest difference in unadjusted odds (OR=0.92, 95% C.I. 0.90-

0.94).

When adjusted for the select characteristics of interest, the odds of having an elective low-risk NTSV cesarean delivery were significantly different based on Appalachian designation and the additional covariates of interest (Table 26). Predisposing characteristics associated with increased odds of elective low-risk cesarean delivery include advancing maternal age, non-white race/ethnicity, increasing educational attainment, and having no prenatal care. Conversely, predisposing characteristics associated with lower odds of elective low-risk NTSV cesarean delivery are increasing maternal body mass, and initiation of prenatal care in the second or third trimester of pregnancy. Relative to higher socioeconomic status, women in at-risk designated counties were at 5% higher odds of having an elective low-risk cesarean delivery. However, women in the most socioeconomically vulnerable counties, designated as distressed, were at 10% lower odds of having an elective low-risk cesarean delivery compared to women of the highest socioeconomic standing, classified as attainment. Women who utilized Medicaid as a payment source were not at a significantly different odds of having an elective low-risk cesarean delivery compared to women who utilized private insurance. Women who utilized self-payment and other forms of insurance were at a higher odds of having an elective low-risk cesarean delivery compared to women who used private insurance.

After adjusting for the covariates of interest, the predicted prevalence of elective cesarean deliveries varied substantially based on Appalachian designation and across the study period (Table 17). The predicted prevalence of elective cesarean deliveries was consistently higher in Southern Appalachia compared to non-Appalachia and the other Appalachian sub-regions.

Northern Appalachia had the lowest predicted prevalence of elective cesarean deliveries compared to non-Appalachia and the other Appalachian sub-regions from 2016 to 2020.

Discussion

The findings of this study indicate that there are significant variations in the prevalence of elective cesarean delivery in the Appalachian sub-regions relative to non-Appalachia. Southern Appalachia had the highest prevalence of elective cesarean deliveries compared to non-Appalachia and the other Appalachia sub-regions. Whereas, Northern Appalachia had the lowest prevalence of elective cesareans. While recent research has illustrated that Central Appalachia consistently has poorer health outcomes relative to the other sub-regions (Hale et al., 2022; Meit et al., 2017b). This has been attributed to long-standing disparities in socioeconomic status, access to health care providers and affordable providers (Hale et al., 2022; Meit et al., 2017b).

It was anticipated that Northern Appalachia would have the highest prevalence of elective cesarean deliveries because research has shown that this sub-region has lower proportions of uninsured women, and lower proportions of counties that are economically distressed (Hale et al., 2022). However, Northern Appalachia had the lowest rates of elective cesarean deliveries suggesting that these maternal-level demographic characteristics and enabling characteristics may not be the primary drivers of elective cesareans in the Appalachian sub-regions. Additional research using data sets which can account for institutional characteristics is necessary to elucidate the factors associated with the inter-regional variations of elective cesarean deliveries beyond what is able to be measured from the birth certificate, such research would allow for the creation of actionable policy change.

This analysis finds that the prevalence of elective cesarean deliveries in Appalachia has decreased significantly from 2016 to 2020. One potential explanation for these decreases may be changing reimbursement structure in the U.S. around elective cesarean deliveries (*Medicaid Payment Initiatives to Improve Maternal and Birth Outcomes*, 2019). Reducing the rates of elective cesareans are a priority area for the Center for Medicare and Medicaid Services (CMS). A number of payment initiatives to reduce the rate of elective cesarean deliveries have been introduced and implemented sporadically across the U.S. (*Medicaid Payment Initiatives to Improve Maternal and Birth Outcomes*, 2019). One such initiative which is potentially driving the decrease in elective cesarean deliveries are reduced payments or nonpayment for elective cesarean sections. Montana Medicaid reduced payments for elective cesareans by 33%, whereas Oklahoma's state Medicaid program dropped the reimbursement rate for elective cesarean deliveries to be equal to the reimbursement for vaginal deliveries (*Medicaid Payment Initiatives to Improve Maternal and Birth Outcomes*, 2019). Recent research conducted by Allen and Grossman, found that nonpayment policies were associated within significant decreases in early-term elective cesarean deliveries among Medicaid enrollees (Allen & Grossman, 2020). In addition to the adoption of revised payment schedules for elective cesarean deliveries in Medicaid programs, private insurers are also following suit and adjusting reimbursements as well.

Another potential driver of the variations in elective cesarean deliveries within Appalachia and across the study period are the cultural and social norms within the sub-regions.

Research has suggested that a woman's beliefs and choices regarding childbearing and birth are predominantly shaped by their cultural belief system (Miller & Shriver, 2012). Appalachia, as a region, has a rich cultural identity. Historically, Appalachians tend to distrust outsiders, particularly health care providers, and base the majority of their health care decisions on experiential stories from family, peers, and neighbors (Bachman et al., 2018; Behringer & Friedell, 2006; Katz et al., 2007). Cultural influences on health care decision making have been largely overlooked in the current body of scholarly literature, and as such future research endeavors should seek to quantify cultural and peer influences on elective cesarean deliveries in order to inform the development of targeted interventions and policies which are both culturally acceptable and efficient.

This study has several strengths. First, this study adds to the existing scholarly literature by updating the current estimations of elective low-risk cesarean deliveries in the U.S. and in the Appalachian sub-regions. Second, this study addresses a substantial gap in the literature by exploring the trends in elective low-risk cesarean sections over time. Historically, it has been difficult to measure the prevalence of elective cesarean sections and as such previous studies tend to focus on cross-sectional data sets within single institutions. In this study, because the 2003 revision of the birth records directly asks, "Was a trial of labor attempted?" we were able to approximate the rate of elective cesarean deliveries more clearly. Lastly, this study uses a well-established, large data source to examine these important issues. However, this study is not without its limitations. First, this study did not attempt to elucidate the causes of the differences in the odds of NTSV or elective cesarean deliveries over the study period. This remains an important area for future research. Second, because income data is not collected on the birth certificate, the ARC economic classifications were used a proxy measure to account for its influence on elective cesarean deliveries. While the ARC economic classification system has been employed by several recent studies on variations in health outcomes (Hale et al., 2022; Meit et al., 2017b), this study applied this county-level assessment of socioeconomic vulnerability to individual women leading to the potential for bias due to misclassification. Similar bias could be associated with the use of the Area Health Resource File's Health Professional Shortage designations to account for variations in health care resources, particularly for women who live in disperse rural counties.

Conclusion

This study examined the differences in the likelihood of elective cesarean deliveries in the U.S. based on geography. As far as the author is aware, this is the first study to examine these outcomes in Appalachian sub-regions relative to national averages. The findings of this study showed that the prevalence of elective cesarean deliveries varied significantly by geography and over the study period. These findings add another layer of nuance to our current understanding of Appalachian health, suggesting that while Appalachia may have higher rates of poor health outcomes that the overutilization of health services may not be a primary driver of those poor health outcomes. In conclusion, the findings of these studies have important public health implications. First, it identifies areas in which the prevalence of elective cesarean deliveries are greatest; thus, indicating potential overutilization of healthcare services. Additionally, this research can serve as a foundation for future research on these outcomes within and outside of Appalachia, as well as interventions to reduce the overutilization of cesarean deliveries.

Appendix C: Field-Based Product – Issue Brief

Low-Risk and Elective Cesarean Deliveries in Appalachia

Kathleen Tatro, MPH

Background

In the United States (U.S.), about one in three infants will be born via cesarean delivery (Martin et al., 2021; Osterman & Martin, 2014b). When medically indicated, cesarean sections can save lives (Kozhimannil, Law, et al., 2013; Roth & Henley, 2014; Sandall et al., 2018). However, when not medically indicated, cesarean deliveries can lead to increased risk for poor health outcomes for both mothers and infants (Henke et al., 2014; Kilpatrick & Ecker, 2016; Matevosyan, 2015; Mylonas & Friese, 2015; Sandall et al., 2018; Weimer et al., 2019). Further, overutilization of cesarean sections leads to poor healthcare quality and excessive health care expenditures. Cesarean delivery rates have been increasing over the last several decades in the U.S. driven predominantly by low-risk and non-medically indicated cesarean sections (Weimer et al., 2019). Particularly troubling is the lack of clear rationale or reasons for these increases (Panda et al., 2018).

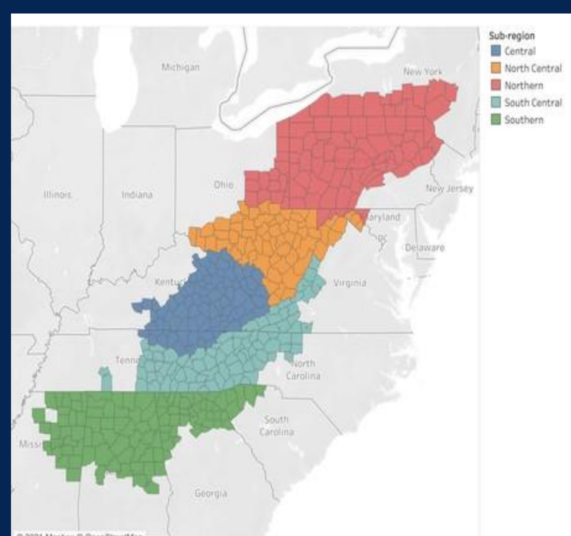


Figure 1: Appalachian Sub-regions

Appalachia (Figure 1) is a culturally distinct region of the U.S. stretching from Mississippi to New York (*The Appalachian Region - Appalachian Regional Commission*, n.d.). Historically, Appalachians have faced a disproportionate burden of poor health and lack of access to health care resources. Additionally, the health disparities seen in Appalachia compared to the rest of the U.S. are well documented, including health disparities related to women's health (Andrews et al., 2019; Hale et al., 2022; Meit et al., 2017a; Pollard & Jacobsen, 2021; G. K. Singh et al., 2017; Thompson et al., 2021).

The purpose of this study was to examine the extent to which the rates and trends in low-risk cesarean deliveries in the U.S. are mirrored within the Appalachian region between 2016 and 2020. Additionally, the rates and trends in elective cesarean deliveries were also examined for the same period of time.

Methods

A retrospective repeated cross-sectional analysis of the prevalence of low-risk and elective cesarean deliveries was conducted. Low-risk cesareans are defined as cesarean sections among nulliparous, term, singleton, vertex pregnancies (NTSV). Elective cesarean deliveries are defined as NTSV cesarean deliveries in which no trial of labor was reported. The primary predictor for this study is Appalachian designation. Appalachia is composed of five sub-regions (Southern, South Central, Central, North Central, & Northern). Additional influential characteristics based on the current body of scholarly literature were included in the analysis. Selection of variables was guided by the Andersen Healthcare Utilization Model. The Andersen

Healthcare Utilization Model purposes that the use of healthcare services is "a function of a person's predisposition to use services, factors which enable or impede use, and a person's need for care" (Andersen, 1995). Predisposing characteristics include demographics, social factors, and beliefs. Enabling characteristics are factors related to an individual's ability to finance the use of health services. Need characteristics refer to individual perception of need and a provider's evaluation of need (Andersen, 1995).

Differences between Appalachian and non-Appalachian women were analyzed using one way analysis of variance (ANOVA) tests for the covariates of interest. Logistic regression modeling was utilized to estimate the unadjusted and adjusted odds of having a low-risk cesarean delivery or an elective low-risk cesarean delivery based on geography. Marginal analyses were conducted to estimate the adjusted prevalence of low-risk and elective cesarean sections while controlling for individual-level sociodemographic characteristics and risk factors.

Hypotheses

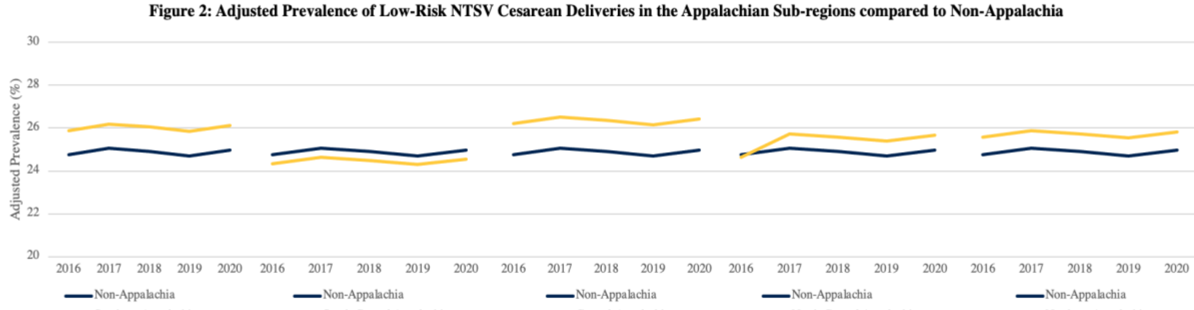
1. The rates of NTSV and elective low-risk cesarean deliveries will be lower in the Appalachian sub-regions relative to non-Appalachia.
2. The rates of NTSV and elective low-risk cesarean deliveries will be highest in Northern Appalachia and lowest in Central Appalachia relative to the other Appalachian sub-regions.

Results

Of the approximately 4.3 million NTSV births in the U.S. between 2016 and 2020, 24.9% were cesarean deliveries. Women who live in the Appalachian sub-regions are less ethnically diverse, have higher rates of health professional shortages, higher rates of obesity, higher rates of women covered by public insurance (Medicaid), and higher rates of common perinatal risk factors (smoking during pregnancy, gestational diabetes, hypertension, etc.).

After adjusting for pertinent sociodemographic characteristics and risk factors, the odds of having a NTSV cesarean delivery was significantly different based on Appalachian designation, though this may be due in part to the large sample size of this analysis. Appalachian women, with the exception of women in South Central Appalachia, were at an increased odds of having a NTSV cesarean delivery compared to non-Appalachia. Additionally, the adjusted prevalence, or frequency, of NTSV cesarean deliveries was significantly different based on region and across the study period (Figure 2). Of particular importance, however, is that across the study period the prevalence of low-risk cesarean deliveries has increased from 2016 to 2020. The rising rates of NTSV cesarean deliveries, a common measure of the quality of perinatal care, suggest the need for further targeted interventions in across Non-Appalachia and the Appalachian sub-regions. Further research to identify causal factors related to the differences in prevalence within the Appalachian sub-regions.

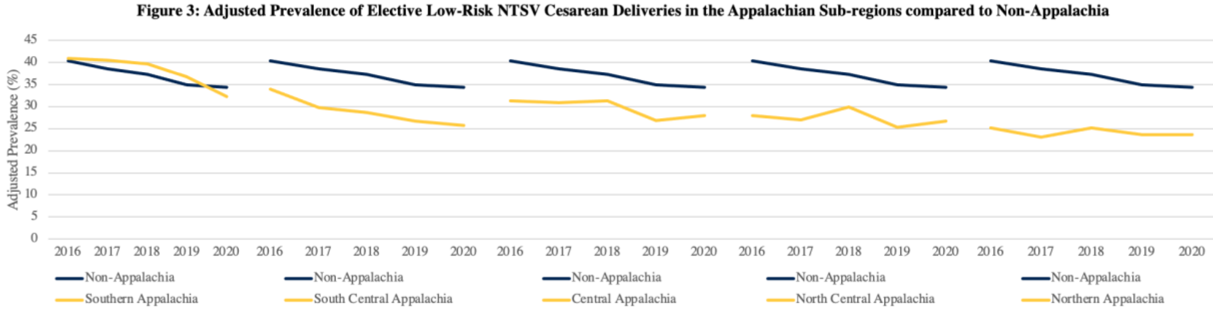
Figure 2: Adjusted Prevalence of Low-Risk NTSV Cesarean Deliveries in the Appalachian Sub-regions compared to Non-Appalachia



Of the approximately 1.1 million NTSV cesarean deliveries in the U.S. between 2016 and 2020, 37% were **elective** low-risk cesarean deliveries. Women who had NTSV cesarean deliveries in Appalachia, as above, are less ethnically diverse, have higher rates of health professional shortages, higher rates of obesity, higher rates of women covered by public insurance (Medicaid), and higher rates of common perinatal risk factors (smoking during pregnancy, gestational diabetes, hypertension, etc.). Women in the Appalachian sub-regions had lower rates of no prenatal care compared to women in non-Appalachia.

After adjusted for predisposing, enabling, and need characteristics, the prevalence of elective cesarean deliveries were significantly lower in the Appalachian sub-regions, with the exception of Southern Appalachia, compared to non-Appalachia (Figure 3). However, it should be noted that Southern Appalachia had the largest decline in elective low-risk cesarean deliveries across the study period. The decline in elective cesarean deliveries is less linear than the decline that was noted in non-Appalachia. This suggests that while efforts to reduce the rates of elective cesarean have been in part successful, further action is needed to continue these declines. One such avenue, is to explore and address the institutional characteristics and policies which have been shown to be influential in the current body of scholarly literature.

Figure 3: Adjusted Prevalence of Elective Low-Risk NTSV Cesarean Deliveries in the Appalachian Sub-regions compared to Non-Appalachia



Recommendations

Reimbursement Structures

A national level policy recommendation to support reductions in NTSV and elective cesarean deliveries is for policy makers to lobby to change labor and delivery reimbursement policies. The current structure of reimbursement, in many ways, incentivizes organizations and providers to utilize cesarean sections over vaginal deliveries, even amongst low-risk women, because these procedures bring a larger return (Hoxha, Syrogiannouli, Braha, et al., 2017; Roth & Henley, 2014). While several insurers have moved to no longer cover elective cesarean deliveries, insurers could also reimburse NSTV cesareans based on subjective measures, such as "non-reassuring" fetal heart tracings, at lower rates. Additionally, insurers should work to cover a broader range of perinatal care providers, such as doulas and midwives. These providers have been shown to be associated with lower rates of low-risk cesarean deliveries (Carlson et al., 2020; Damiano et al., 2020; Hodnett et al., 2013; Kozhimannil, Attanasio, et al., 2014; Kozhimannil, Hardeman, et al., 2013, 2016). Lowering the rates of cesarean delivery rates will lead to improved perception of the quality of care received and lower risk for severe maternal morbidities.

Organizational Policy and Culture Reform

An organizational level policy recommendation to support reductions in NTSV and elective cesarean deliveries is to revise organizational policies around cesarean deliveries. In

2014, the American College of Obstetrics and Gynecology (ACOG) and the Society for Maternal-Fetal Medicine (SMFM) released a joint obstetric care consensus that provided updated guidelines on arrest of labor and failed induction, primary drivers of NTSV cesarean deliveries ("Obstetric Care Consensus No. 1: Safe Prevention of the Primary Cesarean Delivery," 2014). Additionally, this consensus provided new strategies for labor management ("Obstetric Care Consensus No. 1: Safe Prevention of the Primary Cesarean Delivery," 2014). International studies on the impact of the ACOG-SMFM guidelines have shown a significant decrease in the odds of NTSV cesarean delivery after implementation (Thuillier et al., 2018). However, the other studies in the U.S. and abroad have shown mixed results and additional larger studies are needed to clarify the impact of these guidelines on low-risk cesarean deliveries (Jalloul et al., 2021; Kadour-Peero et al., 2021; Thuillier et al., 2018).

A second organizational policy which can be reformed to reduce the rates of NTSV, and elective cesarean deliveries is to employ new models of staffing. The current "traditional" model of staffing, also known as the private practice model, refers to a pattern of practice in which physicians are scheduled to a wide variety of clinical and administrative duties for a number of consecutive days (Bailit, 2012). The primary criticism of the traditional model of staffing is that it may lead providers to preserve their personal and family time (Bailit, 2012). Research suggests that physicians may preserve personal and family time by either delaying the use of labor inducing drugs or preemptively perform cesarean deliveries so that births fall within their working hours. This concept of the preservation of personal time is supported by current research which shows that cesarean deliveries are less likely in the evenings and weekends (Bailit, 2012; Brown, 1996; Burns et al., 1995; Roth & Henley, 2014; Son et al., 2020).

One alternative model of staffing that has been shown to have a positive impact on the rates of NTSV cesarean deliveries that could be employed by health care organizations is the laborist model. The laborist model is a pattern of practice in which a physician is scheduled for 24-hour shifts to exclusively cover clinical duties related to labor and delivery (Bailit, 2012). Evidence has shown that health care organizations who employed the laborist model saw significant decreases in the NTSV cesarean delivery rates, particularly among women who are covered by private insurance (Bailit, 2012; Iriye et al., 2013; Nijagal et al., 2015; Rosenstein et al., 2015).

Conclusion

This study examined the trends in NTSV and elective cesarean deliveries in the Appalachian sub-regions compared to national averages. There were significant differences in the prevalence of NSTV and elective cesarean deliveries in Appalachia relative to non-Appalachia. Further, there were significant differences within the trends of these outcomes within the five sub-regions of Appalachia. These findings support recent research on variations of health outcomes in the Appalachian sub-regions compared to national averages which illustrated a more nuanced view of Appalachian health than previously known. Further research is necessary to elucidate the causal factors associated with the inter-regional variations in NTSV and elective cesarean deliveries.

Addressing the rising rates of NTSV and elective cesarean deliveries through policy efforts, as described here, is critically important as the overutilization of cesarean sections has been consistently shown to be associated with poor health, poor quality of care, and excessive health care costs.

VITA

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Presentations: Hale, N., **Tatro, K**., Orimaye, S. O., Smith, M., Meit, M., Beatty, K. E., & Khoury, A. (2022). Changes in Adolescent Birth Rates within Appalachian Subregions and Non-Appalachian Counties in the United States, 2012–2018. *Journal of Appalachian Health*, *4*(1), 33.

Oral presentation at the virtual 2021 CityMatCH annual conference.

Tatro, K., Cligensmith, R.M., & Morelen, D. (2019). Quality of Life as a Protective Factor Against Substance Misuse Among Adults with a History of Adverse Childhood Experiences (ACEs).

Poster presented at the Appalachian Student Research Forum, East Tennessee State University, Johnson City, TN.