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# Access and Utilization of Prenatal Care in Florida and its Effects on Preterm Birth

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# ACCESS AND UTILIZATION OF PRENATAL CARE IN FLORIDA AND ITS EFFECTS ON PRETERM BIRTH.

by

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# ABSTRACT

Preterm birth in the United States is the leading cause of infant morbidity and mortality. The United States spends more per capita on healthcare than any other nation in the world, and still perinatal outcomes are disappointing when compared to other industrialized nations. Research and current clinical practice guidelines support the use of early and consistent prenatal care to lower risks for preterm birth, by acting as a key mechanism to monitor pregnancy and provide timely and appropriate interventions. Significant research has been completed to identify causative factors that lead to preterm birth. Overall, this literature has not had a substantial impact on decreasing preterm birth rates in the United States. Access to healthcare is one modifiable factor that can be influenced by policy change and potentially have a positive impact on lowering preterm birth rates. This dissertation examines geographical access to prenatal care services in Florida and its influence on preterm birth rates. The researchers used quantitative methods coupled with Geographic Information Systems to evaluate the relationship between potential access to prenatal care and preterm birth rates.

This scholarly project is dedicated to my sons, Ethan and Jameson. You two are my inspiration in all that I do.

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# CHAPTER 1:

# INTRODUCTION

In the United States (US) preterm birth is increasing and for the third year in a row preterm birth (PTB) increased again in 2018 (March of Dimes, 2019). In 2018, the preterm birth rate was 9.95 % which accounted for approximately 377,000 premature babies. For racial minorities in the United States, there is additional risk for preterm birth. In 2018, the preterm birth rate for African American women was 49% higher than the rate among all other women (March of Dimes, 2019). In 2013, researchers estimated employer sponsored healthcare plans spent approximately 6 billion US dollars on caring for preterm infants (Grosse, Waitzman, Yang, Abe, & Barfield, 2017). Annually, Medicaid covers a higher percentage of births than private insurance, and a higher percentage of preterm deliveries are covered by Medicaid (12.7% when compared to private insurance (10.9%) (Markus, Krohe, Garro, Gerstein, & Pellegrini, 2017).

While historically, researchers have sought to identify the causes of preterm birth, there remains no consensus of opinion as to how to decrease PTB in the United States. Recently, the State of Rhode Island implemented a

state-wide effort to improve access to healthcare for women of childbearing age. These efforts improved access for all women to healthcare services such as: prenatal care, intraconception care, preconception care, and access to 17P, which is a medication that can reduce the risk of subsequent PTB in women at risk for premature delivery (March of Dimes, 2019). These statewide efforts lowered the rates of PTB in Rhode Island by 23%.

In the state of Florida PTB rates are higher than the national average, and in 2018 over 10% of all Florida births were preterm. Additionally, from 2013-2016 the average preterm birth rate was 10.6% or higher in 22 Florida counties. African American women living in Florida were 50 % more likely to have a preterm birth (March of Dimes, 2019). Access to prenatal care in Florida can be difficult for women who are attempting to navigate the healthcare system with Medicaid. Annually, approximately 16 % of pregnant women in Florida have inadequate prenatal care during pregnancy most often due to late entry into the healthcare system.

Early and consistent prenatal care have been recognized as an intervention that can reduce preterm birth rates (Van Lerberghe, 2014). Additionally, research has demonstrated that the number of regular health care visits a person receives in one year, is influenced by distance. For

example, as travel distance increases, the number of healthcare visits a patient has in one year is lower (Arcury, et al., 2005).

Several conceptual models related to healthcare access and utilization are recognized in the literature. For the purposes of this study Andersen's Behavioral Model of Access to Medical care was utilized (Andersen, 2008). The model defines realized access as the ability of a woman to use health services. Inequitable access occurs when social structure, health beliefs, and enabling resources determine who gets medical care. For women seeking prenatal care in Florida, they face multiple societal barriers that are unique to our United States healthcare system. In the absence of universal access to healthcare, social structure, health beliefs and enabling resources may determine who gets medical care (Aday & Andersen, 1974).

The study was a descriptive study of a retrospective cohort of all preterm births in Florida from 2013-2017. Geographic information systems (GIS) software provided an empirical measure of distance and visual identification of areas with decreased access to prenatal care services. GIS is a computer software system that provides cataloging, storing, analyzing, and displaying geographical spatial data. The dissertation will be completed in a nontraditional dissertation format with three completed manuscripts. The

study findings will be disseminated through peer reviewed publications and presentations to increase awareness of healthcare disparities associated with preterm birth and influence policy change in Florida to improve access to healthcare for women and their babies.

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# CHAPTER 2: INFLUENCE OF ACCESS TO PRENATAL CARE ON POOR BIRTH OUTCOMES: AN INTEGRATIVE


## Abstract

*Introduction:* This article presents an integrative review of the literature examining the relationship between access to prenatal care and preterm birth rates in the United States.

*Methods:* Original research published from 2006-2018 was collected using MEDLINE, CINAHL, Web of Science, and PsycINFO. Articles were assessed for inclusion using the Preferred Reporting Items for Systematic Review and Meta-Analysis 2009 framework.

*Results:* Seventeen studies were included in this review. During the review a relationship was found between access to prenatal care, utilization of care coordination services, and adequacy of prenatal care. These identified interventions all were important factors in impacting preterm birth.

*Discussion:* Timely access to prenatal care may serve as a key mechanism to monitor pregnancies and allow for identification of problems and appropriate interventions. Interventions that will improve perinatal outcomes

must be available and accessible for all women regardless of ethnicity, race, or ability to pay.

*Keywords: premature birth, prenatal care, health care access, integrative review, healthcare quality, pregnancy, low birth weight*

## Influence of Access to Prenatal Care on Poor Birth Outcomes: An Integrative Review

The United States is historically recognized as a country that provides excellent care to the sickest patients, with significant healthcare research funding focused on treatment of disease processes. It is widely known that the United States has the highest healthcare expenditures per capita in the world (Goldenberg & Jobe, 2001; Hagland, 2014). Even with high expenditures for healthcare research in the United States, funding opportunities have not targeted women's healthcare and not significantly impacted healthcare outcomes. However, the high prevalence and burden of healthcare costs of preterm birth (PTB) prompted a recent increase in research funding to identify the causes of preterm labor (Hagland, 2014). Still, there remains no consensus of opinion as to how to decrease rates of PTB in the United States. Furthermore, while significant racial disparities exist in prenatal care delivery, no specific causes for these disparities have been identified (Alkema et al., 2016). Universal access to prenatal care is the standard in much of the industrialized world and results in improved perinatal outcomes and reduced healthcare disparities for women. In the current United States health care environment, it is imperative that researchers focus on disparate research that improves health outcomes and

influences policy change to improve access and utilization of obstetrical healthcare services.

## Background

The World Health Organization (WHO) reported in the United States, maternal and infant mortality (IM) rates are increasing annually, when compared with other industrialized countries. Currently the United States ranks 61st globally for maternal health outcomes, and is the lowest ranking developed country (Alkema et al., 2016). Preterm birth is defined as a live birth before 37 completed weeks of pregnancy, and the leading cause of infant mortality in the United States. Approximately 75% of neonatal deaths occur due to complications from preterm birth (American College of Obstetricians and Gynecologist [ACOG], 2013; Goldenberg et al., 2001; World Health Organization [WHO], 2010). Annually, over 350,000 babies are born annually before 37 weeks of gestation (Martin, Hamilton, Osterman, Driscoll, & Mathews, 2017, 2018). Of the neonates that survive the neonatal period, they are twice as likely to die in the first year of life (Callaghan, MacDorman, Rasmussen, Qin, & Lackritz, 2006). Additionally, greater than half of them suffer lifetime health challenges, and it is estimated

that the healthcare expenditures for preterm neonates exceeds 16 billion annually (Behrman & Butler, 2007). The lifetime cost of care for preterm neonates has been acknowledged as the highest cost population for health insurance companies (Jones, Istwan, Jacques, Coleman, & Stanziano, 2002). Finally, Healthy People 2020 recommends an increase in the proportion of pregnant women who receive early and adequate prenatal care by 10% (U.S. Department of Health and Human Services, 2010). Additionally, the WHO and the Centers for Disease Control and Prevention (CDC) have called for an increase in access to early and comprehensive prenatal care as a means of reducing maternal and infant mortality (Centers for Disease Control and Prevention [CDC], 2008; WHO, 2015).

Preterm births are not evenly distributed throughout the United States (Thompson, Goodman, Chang, & Stukel, 2005). It is hypothesized that evaluating the distribution of risk factors for PTB, including sociodemographic, racial, ethnic, and medical/obstetrical factors can explain this variation. There is limited research evaluating variations of access and their influence on PTB rates (Van Lerberghe et al., 2014). Utilization of early and adequate prenatal care has demonstrated its ability to lower risk for PTB (CDC, 2008; WHO, 2015). Finally, practice variations among

healthcare providers can affect quality of care and contribute to delivery outcomes and is a modifiable cause of PTB (Eibich & Ziebarth, 2014).

The purpose of this integrative review is to provide a comprehensive overview of the current research on prenatal care access and how removal of barriers that improve accessibility of prenatal care can positively impact PTB rates in the United States. This review will provide a broad overview of the literature, various study methods and evidence available to demonstrate the importance of early onset, high quality, comprehensive prenatal care when attempting to lower PTB rates throughout the United States for women of all races, ethnicities, and socioeconomic levels.

## Methods

The preferred method of reviewing items for an integrative review, the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) framework, was used for locating, reviewing and evaluating original research on access to prenatal care and pregnancy outcomes. Medical Subject Headings (MeSH) were used to search for research studies and included the following terms: “premature birth,” “prenatal care,” “maternal health services,” “healthcare quality, access, and evaluation,”

"healthcare access," and "healthcare disparities." The following inclusion criteria were used: 1) original qualitative and quantitative research; 2) studies that focused on the influence of access to prenatal care on birth outcomes; 3) studies that evaluated PTB as a pregnancy outcome; 4) studies conducted in the United States; 5) research published in an English language peer-reviewed journal. Articles were excluded if they evaluated women who had migrated to the country during pregnancy.

Using the inclusion criteria, MeSH terms were entered into MEDLINE, CINAHL, Web of Science and PsycINFO and searches were completed to include the years 2006-2018 with 1,111 articles initially retrieved. During review of articles obtained, 313 were removed as duplicates. The searches and references list from studies found one additional study that was included in the integrative review.

Preliminary title and abstract reviews were performed on 799 articles. The author identified 50 articles that were included for full article review. Of these 50 articles, an additional 33 articles were excluded because they were not original research or did not study the target population. This process resulted in 17 published studies meeting the eligibility criteria and were included in the integrative review, delineated in Figure 1.

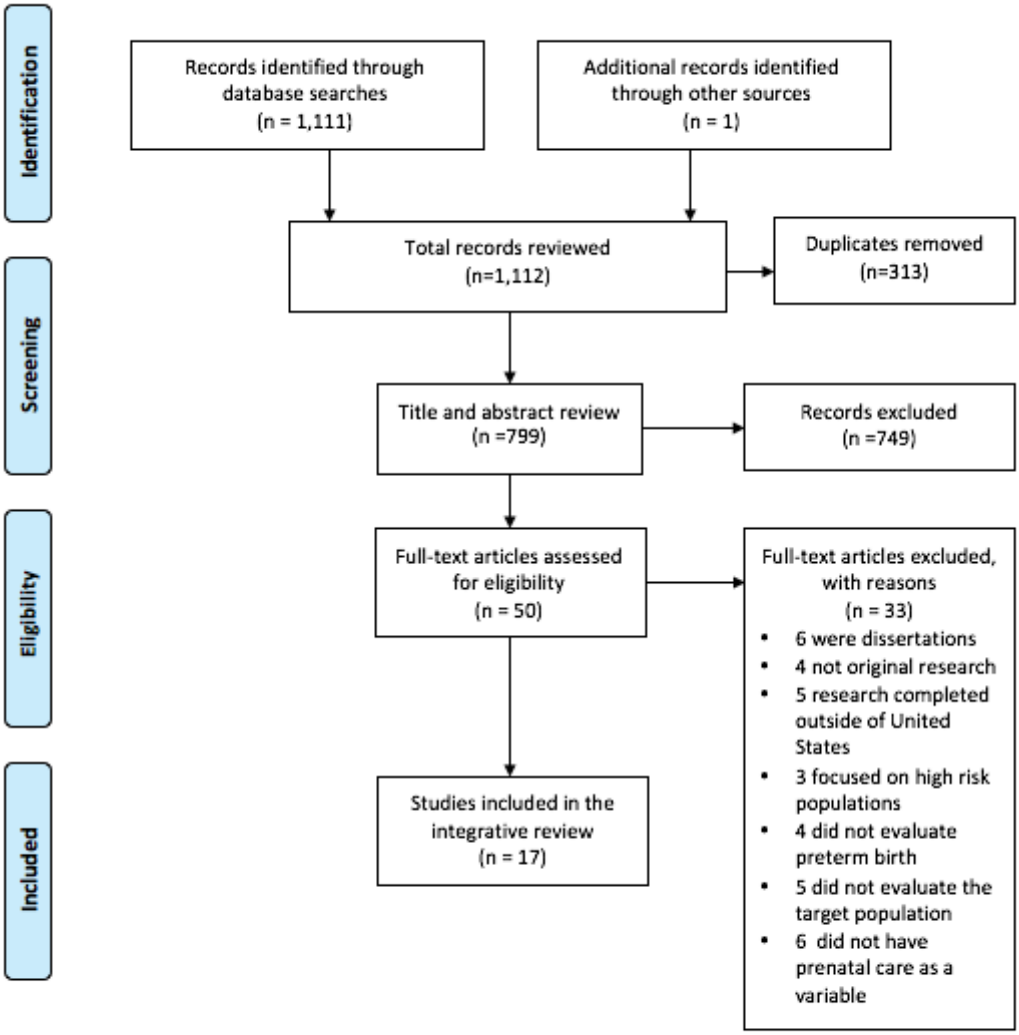


*Figure 1:*Diagram of Literature Collection Process

# Results

## Access to Care

The ability to enter a healthcare system and receive prenatal care has been a limitation for many women seeking care in the United States. This is due to barriers that make realized accessibility into complex healthcare systems difficult. Studies have consistently shown that women with delays in access to prenatal care or delays in enrollment into the Medicaid system have higher rates of PTB (Cox, Zhang, Zotti, & Graham, 2011; Zeitlin, Blondel, & Ananth, 2015). Women seeking care in the United States are more often using public health insurance, such as Medicaid, in a private healthcare environment, leading to limitations in resources. Research demonstrates that even as physician supply increases, the number of Medicaid participating physicians does not (Adams, Gavin, & Benedict, 2005). Moreover, women who are enrolled in Medicaid often live in areas with the highest poverty rates and have an increased likelihood of higher rates of PTB (DeFranco, Lian, Muglia, & Schootman, 2009; Kozhimannil, Casey, Hung, Prasad, & Moscovice, 2016) .

Late entry to care was found to be directly related to poor birth outcomes in the United States (Anum, Retchin, Garland, & Strauss, 2010;

Harris, Aboueissa, Baugh, & Sarton, 2015; O'Connell, Zhang, Leguen, & Prince, 2010; Partridge, Balayla, Holcroft, & Abenhaim, 2012; Zeitlin et al., 2015). This is in part due to shortages of healthcare providers, particularly providers of primary care. Some states lack healthcare services for prenatal care in rural areas, thereby forcing pregnant women to travel long distances for care. Any distance greater than 30 minutes was considered a barrier to access in the United States (Cox et al., 2011; Sparks, 2009). While no studies were conducted to explore acceptable travel time from home to hospital for women seeking care in pregnancy, research completed in the Netherlands found that the travel time of 20 minutes or less lowered the risk of adverse pregnancy outcomes (Ravelli et al., 2011).

Research findings regarding access to care for pregnant women vary based on state scope of practice regulations of both nurse practitioners and certified nurse-midwives (Markowitz, Adams, & Dunlop, 2016; Traczynski & Udalova, 2013). Harris et al. (2015), found that in Maine the expansion of scope of practice for all APNs led to significant improvement in maternal healthcare outcomes when compared to states with restrictive or supervisory practice. A study conducted in Pennsylvania, a state with restricted APN practice, found that poor access to health promoting services increased poor

perinatal outcomes for rural women (Hillemeier, Weisman, Chase, & Dyer, 2007). Mobile prenatal care services initiated to move services to the patients with geographic disparities improved prenatal care utilization and improved birth outcomes by lowering PTB rates (Anum et al., 2010; Cox et al., 2011; Newman et al., 2008; O'Connell et al., 2010). Additionally, more women entered care in the first trimester and continued to receive consistent care throughout the pregnancy when geographic disparities were corrected (Anum et al., 2010; Coley & Aronson, 2013; Cox et al., 2011; Newman et al., 2008; O'Connell et al., 2010). Researchers that utilized targeted interventions to decrease barriers to care, noted improved outcomes in rural populations by decreasing disparities in PTB, IM, and neonatal intensive care admissions (Anum et al., 2010; Newman et al., 2008; Sparks, 2009).

## Adequacy of Prenatal Care

Adequacy of prenatal care in the United States traditionally has been measured using the Kotelchuck's and Kessner indices, both reliable and valid forms of measurement (Kessner et al., 2002; Kotelchuck & Kotelchuck, 1994). The indices consider time of entry into care, as well as the number of prenatal care visits that occur during a pregnancy. Eight

studies used these indices and found that early access to care and consistent, regular follow-up throughout the pregnancy were associated with improved birth outcomes (Anum et al., 2010; Healy et al., 2006; O'Connell et al., 2010; Partridge et al., 2012; Sparks, 2009; Tucker et al., 2015; Whitehead, 2012; Zeitlin et al., 2015). Prenatal care allowed for implementation of effective and appropriate screening, education, preventative interventions and frequent assessment of pregnancy progression. Multiple studies found that as women participate in greater amounts of prenatal care the frequency of poor birth outcomes drops (Newman et al., 2008; O'Connell et al., 2010; Partridge et al., 2012; Sparks, 2009; Whitehead, 2012). Additionally, studies evaluating the adequacy of care and birth outcomes underscore the importance of early and regular prenatal care. Women who enter care later in pregnancy are at increased risk for PTB (Whitehead, 2012; Zeitlin et al., 2015).

## Racial Disparities

Racial disparities in PTB and infant mortality rates in the United States have been discussed in the literature for many years. Black women in the United States are at significant risk for poorer perinatal outcomes when

compared to women of all other races (Anum et al., 2010; Cox et al., 2011). One study compared perinatal outcomes for racial minorities in the United States and France (Zeitlin et al., 2015). Black women in France were not at increased risk for PTB, whereas in the United States the majority of studies identify race as a significant risk factor for PTB and poor perinatal outcomes. Black women have a 47% increased risk for PTB when compared to white women in the United States (Anum et al., 2010).

Black women consistently experience disproportionate rates of perinatal and infant mortality when compared to all other races and ethnicities. When prenatal care was delivered appropriately, several studies demonstrated an increased risk for PTB for black women in the absence of late or inadequate prenatal care (Coley & Aronson, 2013; Cox et al., 2011; Healy et al., 2006; Hillemeier et al., 2015; Partridge et al., 2012; Sparks, 2009). Equitable distribution of healthcare services among women of different races is also a concern. Cox found that black women with medical conditions that complicate pregnancy were twice as likely to receive less than adequate prenatal care when compared with their white peers (Cox et al., 2011) .

## Care Coordination

Nationally, care coordination in pregnancy generally targets at risk maternal populations in areas with limited healthcare accessibility (Sparks, 2009). Care coordination programs work to decrease barriers to prenatal care, and also address nutritional, psychosocial and resource needs of the pregnant mother (Hillemeier et al., 2015). Many care coordination programs are state funded, varying in focus and structure throughout the nation. Limitations in funding, maternal participation, or public awareness of programs are barriers that decrease the efficacy of care coordination interventions.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), a US program that is available to eligible women to provide care coordination, basic prenatal screenings and food vouchers, improves perinatal outcomes (Cooper, Scharff, Elliott, & Rotter, 2013; Khanani, Elam, Hearn, Jones, & Maseru, 2010). These programs encourage women to seek prenatal care early and provide resources for referral to quickly enter the health care system. WIC programs also offer monitoring of continuity of care and additional care coordination by encouraging patients to return for consultation and evaluation to obtain further nutritional assistance. Studies

were conducted to evaluate the efficacy of WIC on perinatal outcomes and found lower rates of infants weighing less than 2500g at birth, infant mortality and, decreased rates of PTB when compared to women who did not participate (Cooper et al., 2013; Khanani et al., 2010; Sparks, 2009). In one study, participation in care coordination lowered the rates of PTB by 20% (Hillemeier et al., 2015).

Care coordination for women increased the number of contact hours women had with a healthcare professional for education and coordination of care. Often women who seek care in community health centers, health departments or busy obstetrical practices receive limited pregnancy education (Van Dijk, 2008). Increased contact hours are necessary to improve perinatal outcomes (O'Connell et al., 2010; Van Dijk, 2008). Furthermore, six or more direct contact hours of prenatal education and coordination, improved birth outcomes when compared to births for women who received less education or care coordination (Van Dijk, 2008).

Zeitlin et al. (2015), compared the differences in care coordination for pregnant women between France and the United States. Social programs in France offered extensive perinatal education and mediated stress in pregnancy. Women in France had consistently improved perinatal outcomes

including decreased PTB rate when compared to the United States (Zeitlin et al., 2015). Greater than 60% of women were identified as at-risk in the United States and require care coordination and expanded social services (Tucker et al., 2015). Risk assessment and referral to care coordination in the United States needs to be expanded in order to positively influence maternal and neonatal outcomes (Van Dijk, 2008).

## Discussion

Evidence suggests that early onset of prenatal care combined with high quality, frequent and comprehensive evaluation during the prenatal period positively impacts birth outcomes for all women. Currently there is no gold standard on delivery of prenatal care. Wide differences in prenatal care limit researchers' ability to control for variations and determine causative mechanisms of PTB related to care. Research is needed to identify objective measures to guide healthcare practitioners in providing prenatal care that is standardized and measurable to ensure improved outcomes for all women.

Current standards for determining adequacy of prenatal care are inexact: access to prenatal care has been measured by the presence or

absence of healthcare services in a community. These measures assume equal access for all individuals without concern for ability to migrate to care or the geographic barriers surrounding the community. Kotelchuck's and Kessner indices are based on documentation of week of pregnancy at time of entry into care and the subsequent number of visits and do not consider high-risk pregnancies or the importance of perinatal education in their models (Bloch, Dawley, & Suplee, 2009). Women, who received some prenatal care equivalent to adequate-plus (care initiated before 4 months of pregnancy and 110% or more of the recommended visits received), were at the highest risk for PTB. High-risk pregnancies are closely followed because of medical complexity, but current measurement tools do not consider this (De Marco, Thorburn, & Zhao, 2008; Kogan, Kotelchuck, & Alexander, 1994). Racial disparities in the United States are prevalent when evaluating black women and PTB rates. A significant amount of research acknowledges inequities in care in this marginalized population, but limited research evaluates geographic disadvantage for marginalized women living in areas of limited resources. Therefore, increased research funds must be allocated at the federal and state levels, to improve healthcare outcomes for this at-risk population.

## Recommendations for Future Research

Future research is needed to understand personal, geographic and societal barriers that limit access for women who seek prenatal care. Research that identifies and evaluates the geographic disadvantages women experience when seeking prenatal care is needed to improve accessibility for all women. Research should also further evaluate the effects of various levels of scope-of-practice for nurse practitioners, certified midwives, and certified nurse-midwives. In states with full practice authority improved outcomes for women and babies were noted, but in states with restrictive or supervisory laws, outcomes vary. Furthermore, rural areas often have the poorest outcomes, thus research is needed to examine geographic disadvantages. Securing healthcare for isolated areas, as well as, the poorest urban and rural residents who have significant barriers to care is critical.

## Conclusion

Providing women with early and adequate healthcare is imperative to the improvement of all perinatal outcomes, including PTB. Timely access to prenatal care may serve as a key mechanism to monitor pregnancies and allow for early identification of problems and appropriate interventions. Further research is needed to evaluate the quality of prenatal care based on

improved standardization of perinatal education. Finally, interventions that will improve perinatal outcomes must be available and accessible for all women regardless of ethnicity, race, or ability to pay.

*Table 1:* Integrative Review Evidence

| **Authors** | **Design, Participants and Methodology** | **Study Purpose Measure of Health Outcomes** | **Adequacy of Prenatal Care Measure** | **Results** |
|---|---|---|---|---|
| Anum et al. | Retrospective cohort analysis<br><br>Singleton Medicaid births (N=211,724)<br><br>Medicaid (n=26.7%)<br>Private Insurance (n=66.8%)<br>Self-Pay (n=6.5%) | To evaluate if payment method and adequacy of preterm birth were associated with preterm birth risk in the Virginia Medicaid population from 2007-2008. | Adequacy of PNC was based on Kotelchuck's index. | Multivariate logistical regression was used to adjust for known risk factors for preterm birth. Compared to women with private insurance, women on Medicaid had an (odds ratio [OR], 0.99 (0.94-1.03)). Self-pay mothers had a 32% increase in risk for preterm birth 1.32 (1.23-1.42).<br><br>All payment groups showed a significant reduction in preterm birth prevalence as adequacy of prenatal care improved. |
| Coley et al. | Cross sectional study<br><br>N=10,515 Singleton births to non-Hispanic white or Black teen mothers in North Carolina in 2009.<br><br>African American (AA) (n=47.2%)<br>Non-Hispanic White (n=52.8%) | To determine if prenatal care utilization influenced disparities in birth outcomes between AA and white teen mothers. | Adequacy of PNC was based on Kotelchuck's index. | AA race had a significant, negative association with low birth weight β=-0.18; P <0.001).<br><br>An inverse association was noted between gestational age and inadequate prenatal care ((β=-0.08, P <.001).<br><br>Racial disparities were noted in study demonstrated by AA teen mothers experienced lower levels of prenatal care adequacy and higher rates of low birth weight and preterm birth. |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
|---|---|---|---|---|
| Cooper et al. | Retrospective case-control design.<br><br>St. Louis Healthy Start (SLHS) participants (n=84) between 2006-2008)<br><br>Matched controls (n-168)<br>Unmatched controls (n=7,623) | The purpose of the study was to evaluate the effectiveness of the SLHS program in increasing the participation of underserved women in prenatal care.<br><br>Additionally, researchers were interested in the effects of prenatal care utilization on low birth weigh, preterm birth and use of additional health services. | Adequacy of PNC was based on the Kotelchuck index. | The results showed that participation in the SLHS program decreased the rate of preterm births and low birth weight infants when compared to the matched control group.<br><br>When compared to the matched control group women who participated in SLHS were 75 percent less likely to have a preterm delivery (OR=0.25; CI =0.08-0.74; P=0.012). |
| Cox et al. | Retrospective population based cohort.<br><br>N=292,776 (91.6% of all births) viable singleton live infants born to non-Hispanic or Black mothers in Mississippi from 1996-2003. | The purpose of the study is to identify racial disparities in prenatal care utilization and to determine the relationship between prenatal care and preterm birth, low birth weight, and infant mortality. | Adequacy of PNC was based on the Kotelchuck index. | PNC utilization:<br>Black women were significantly more likely to received inadequate and no care during pregnancy.<br><br>Inadequate PNC Black vs. White<br>16.4% vs. 5.9 % P<.0001<br>No prenatal care Black Vs. White<br>1.6% vs. 0.3% P<.0001<br><br>Regardless of race women who received inadequate or no prenatal care had a significant increased risk for preterm birth. |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
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| DeFranco et al. | Population based study.<br><br>N=634,994 singleton live births in Missouri from 1989-1997. | The purpose of the study is to evaluate a large population birth registry to estimate the independent effect of county level poverty on preterm birth risk. | Birth certificate data was obtained from the Missouri birth certificate database. Known risk factors for PTB were controlled for.<br><br>Poverty rate information was obtained from the US census data. | Women living in counties with high poverty rates had and increasingly disproportionate rate of inadequate prenatal care. Rates listed from 1st to 4th quartiles (9.0%, 10.8%, 15.5%, 21.7%, P<0.0001).<br><br>Women living in the highest poverty rate counties were at increased risk of PTB at <35 weeks and <32 weeks of gestation (OR 1.18, 1.27).<br><br>White women with inadequate PNC in the poorest counties were less likely to have a PTD than black women at both <35weeks (OR 1.13 vs 1.30) and <32 weeks (OR 1.18 vs. 1.22). |
| Harris et al. | Retrospective cohort analysis<br><br>N=12,561 Maine births from 2000-2010.<br><br>Maine births were located:<br>3,575 urban<br>2,649 suburban<br>3,905 rural | The purpose of this study is to determine the impact of rurality on maternal and child health. The researchers aimed to define the differences in pre pregnancy, prenatal, and postpartum health related variables in both rural and urban settings in the state of Maine. | PRAMS results analyzed and results were coded into a geographic information system program. Mothers were assigned a rurality tier (urban, suburban, large rural town, or isolated rural community based on the reported maternal residence. | Rural mothers were younger 10.5% teenage pregnancy rate in rural areas vs 6.2% in urban areas. Additionally, mothers from rural areas were less well educated, lived in low-income households (39.6% vs. 28.8%), and rural mothers had higher average BMI (26.1 vs 25.3).<br><br>First prenatal visit for all populations was 8.6 weeks age.<br><br>No differences among rurality tiers in cesarean section rates, PTB rates, or low birth weight infants. |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
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| Hillemeier & Domino et al. | Retrospective cohort study<br><br>N=7,124 women delivering infants in North Carolina from October 2008 to September 2010. Control group (mothers not receiving prenatal care coordination): n=4,869<br><br>Intervention group (mothers receiving at least on care coordination visit): n=2.225 | The purpose of the study was to evaluate the effects of maternity care coordination on pregnancy outcomes in North Carolina (NC). | Data was collected from and electronic birth certificate database matched by the NC Center for Health Statistics to both newborn and maternal Medicaid records, and Medicaid Maternity Care Coordination(MCC) claims. | Mothers participating in MCC had a decrease in PTB when compared to control group (-0.0129 vs. -0.0197; P<0.0067).<br><br>Participation in the MCC decreased rates of PTB (19.5% vs. 14.3%; P<0.0006). |
| Hillemeier & Weisman et al. | Retrospective cohort study<br><br>N=11,546 singleton births to women residing in a 28 county region of Pennsylvania in 2002.<br><br>Vital record data was merged with zip code level information from the census and residence in a primary care health professional shortage area. | To examine the relationship of individual and community level socioeconomic, health care and health status-related characteristics to preterm and low birth weight outcomes among women living in urban and various types of rural communities. | Kotelchuck's index was used to measure PNC adequacy. | Inadequate prenatal care was found to be a statistically significant individual level characteristic in estimating preterm birth risk (OR 2.24; 95% CI, 1.70-2.95).<br><br>Women living in the 2 most rural types of communities were shown to experience risk of poor birth outcomes as great as those found among women living in urban-focus communities. |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
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| Khanai et al. | Retrospective cohort design<br><br>N=24.008 singleton pregnancies<br><br>Hamilton County Ohio WIC prenatal participants (n=9747) Between 2005-2007<br><br>Comparison group (n=14,261) | The purpose of the study is to assess the value of Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) services in Hamilton County, Ohio as public health intervention seeking to improve birth outcomes and reduce racial disparities. | Adequacy of prenatal care measured by trimester patient entered into WIC services. | African American preterm birth rates<br>Preterm birth (WIC vs. comparison) 13.7% vs. 20.0% P<.001)<br><br>Entry into healthcare system:<br>WIC Participants vs. Comparison Group<br>1st trimester 26.6% vs. 64.8% (P<.001)<br>2nd trimester 44.4% vs. 19.9% (P<.001)<br>3rd trimester 29.0% vs. 4.0% (P<.001)<br>No or unknown prenatal care (11.4%) of comparison group. |
| Newman et al. | South Carolina based partnership in 8 counties that screened Medicaid recipients. Women with identified risk factors were offered case management.<br><br>Control group: Retrospective Medicaid births from 2004 born to mothers in the targeted area in South Carolina (n=13,363)<br><br>Intervention group: Medicaid recipients in 8 counties in South Carolina (n=6,356) | The purpose of the study is to improve the distribution of PTB in a Medicaid population through a regional perinatal risk assessment and case management initiative. | Data collections were from risk assessment data obtained during phone calls by perinatal nurses, birth certificate data, statewide hospital discharge data, and detain from Medicaid services clinic management databases. | In the LC perinatal region, there was no difference in PTB 32-36 6/7 weeks between 2004 and 2006 (10.1% vs. 10.4%; P =0.69).<br><br>There was a significant improvement in the distribution of PTB less than 28 weeks in 2006 when compared with the control group (1.6% vs. 1.1%; P =0.29); RR 0.75; 95% CI, 0.51-0.96).<br><br>Increased access to nursing services and healthcare professionals combined helped to lower PTB rates. |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
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| O'Connell et at. | Convenience sample of 182 mothers in Miami Dade county who utilized mobile prenatal care services between August 2007 and September 2008. | This study was performed to evaluate the influence of mobile prenatal care to utilization of care and birth outcomes in a diverse population in the Miami-Dade County for women who did and did not use mobile prenatal care services. | Adequacy of PNC was measured using both Kessner and Kotelchuck Indices. | PNC utilization was improved in the Mobile group and more mothers in the mobile group started PNC in the 1st trimester.<br><br>A significant higher proportion of women were classified as having adequate PNC on the Kotelchuck Index when comparing the mobile group to the comparison group (77.5 vs. 61.5, P <0.0001).<br><br>The percent of PTB was significantly lower in the Mobile group compared to the Comparison group (5.0% vs. 10.4%, P =0.0492). |
| Partridge et al.<br><br>Analysis was limited to singleton births >22 weeks and with no known congenital malformation (n=28,729,765) | Population based retrospective cohort study.<br><br>The researchers conducted a retrospective cohort analysis for 8 years, using the CDC dataset. The cohort files contained approximately 8.5 million births. | To evaluate the association between adequacy of prenatal care utilization and risk of fetal and neonatal mortality and adverse outcomes.<br><br>Largest population based cohort study to evaluate the association between adequacy of PNC utilization and risk for adverse outcomes. | Adequacy of Prenatal Care Utilization Index<br><br>Inadequate care was defined as care initiate after 4 months' gestation or fewer than half of the predicted visits. | Inadequate PNC was associated with increased risk for all adverse outcomes. Stillbirth, early neonatal death, late neonatal death, and infant death showed a linear increase in risk with decreasing PNC relative to adequate care.<br><br>In women with inadequate prenatal care 13.3% had a PTB this was statistically significant when compared to women with adequate prenatal care.<br>Inadequate PNC:<br>Preterm birth (13.3%, OR 3.75, 95% CI, 3.73-3.77;P <0.0001).<br><br>Mothers who received less than adequate PNC were disproportionally black, under 20 years old, and educated less than HS education. |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
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| Sparks | Probability sample of children born between January and December 2001. Variables were constructed from a known dataset using birth certificate and parental interviews.<br><br>United States singleton live births in 2001 (N=9,050) | To evaluated the existence and possible explanation(s) for racial/ethnic disparities in PTB using a diverse set of racial/ethnic categories and a nationally representative sample of births. | Kessner Index. | Preterm birth rates were highest among Native American women and Non-Hispanic Black Women (22.86% vs. 15.76%).<br><br>Native American mothers were most likely to receive no prenatal care (14.61%).<br><br>Non-Hispanic black mothers are 72% more likely to have PTB compared to Non-Hispanic white mothers (15.7569; P <0.001).<br><br>Women who received no prenatal care or inadequate prenatal care had increased risks for PTB.<br>No PNC (OR=7.49),<br>Inadequate care (OR=3.21) |
| Tucker et al. | Retrospective cohort analysis<br><br>Pregnant Medicaid patients screened by the Pregnancy Medical Home program before 24 weeks' gestation who had a live birth in North Carolina between 9/2011-9/2012.<br><br>N=15,428 | To provide insight and determine which risk factors from the Pregnancy Medical Home (PMH) screening best predict PTB and to delineate if certain risk factors are more predictive by parity or race/ethnicity. | Data was obtained from the Community Care of North Carolina (CCNC) Case Management Information System (CMIS). | The overall all prevalence of PTB was 11.0%.<br><br>Non-Hispanic black race was the only sociodemographic factor that was a predictor of PTB (13.04%; P <0.01).<br><br>Smoking was the only psychosocial risk factor that increased rates of PTB.<br><br>Care management improves ability of healthcare professionals to focus on risk reduction, screening, and rapid intervention of identified complication that lead to increased rates of preterm delivery. |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
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| Whitehead et al. | Retrospective cohort analysis of PRAMS datasets of 27 states from 2000-2002.<br><br>N=107,926 | The purpose of this study is to determine the relationship of socioeconomic status (income, maternal education, and type of insurance) with preterm contractions and preterm delivery. | PRAMS data from 27 states used for data analysis. Initiation of prenatal care was self reported. | PTD was 50% more common in the lowest 5% of income (19.2%, RR 1.0).<br><br>Women who had 12 years of fewer of education (18.8%, RR 1.0) or were receiving Medicaid (18.4%, RR1.0) were at higher risk for preterm delivery when compared to women with more than 12 years of education (8%) or private insurance. |
| Willems Van Dijk et al. | Cross sectional study design to compare birth outcomes for Medicaid enrolled women in Wisconsin from 2001-2002 who did not receive prenatal care coordination (PNCC) vs. Medicaid enrolled women who received PNCC.<br><br>Total Medicaid births (N=45,406)<br>Mothers who received PNCC (n=10,715)<br>Mothers who did not received PNCC (n=34,691) | The purpose of the study is to measure the impact of Wisconsin's PNCC on birth outcomes. | Women were selected using a standardized questionnaire to be considered for placement in the PNCC group. | Women who received Medicaid had higher preterm birth rates (12.7% vs 1.3%) when compared to total population.<br><br>PNCC reduced the risk of having a PTB by 17% ([OR] .831; 95% [CI], .776-.890).<br><br>Women who received 6 or more hours of services/education were less likely to delivery infants with poor birth outcomes (OR .774; 95% CI, .657-.842).<br><br>Women who had no prenatal care or entered prenatal care after 4th month of pregnancy were 20% more likely to delivery a preterm infant (OR 1.2; 95% CI; .1.041-1.383). |

| Authors | Design, Participants and Methodology | Study Purpose Measure of Health Outcomes | Adequacy of Prenatal Care Measure | Results |
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| Zeitlin et al. | Retrospective analysis of the United States birth certificate datasets and French Perinatal Survey.<br><br>Years evaluated 1995, 1998 and 2003 in France and all states except California.<br><br>Included births were all singleton births over 22 weeks' gestational age with a birth weight of at least 500g.<br><br>Total sample size: (N=9,961,998)<br>United States (n=9,922,287)<br>France (n=39,701) | To examine differences in socioeconomic characteristics of pregnant women and obstetrical interventions during pregnancy to explain the high rate of PTB in the United States when compared to France. | Researchers included timing of first prenatal visit (first, second, or third trimester) and the number of prenatal visits. | Women in the United States had a 70% higher risk for preterm delivery. Total preterm birth rates in United States 7.9% and France 4.6% (RR 1.7; 95% CI, 1.6-1.8).<br><br>In United States black race was associated with increased risk for PTB (12.1%). In France, black women did not have an increase in PTB, increased PTB rates were noted noted in non-citizens from Africa (6.2%).<br><br>US women were more likely to start prenatal care later. 16.5% had their first visit in the 2nd or 3rd trimester vs. 4.5% in France. |

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# CHAPTER 3: GEOGRAPHIC INFORMATION SYSTEMS NURSING RESEARCH METHODS: CONCEPTS, METHODS, AND LIMITATIONS


## Abstract

The application of Geographic Information Systems (GIS) in nursing is relatively new, and lags behind the use of GIS in other sciences. GIS is a computer software that captures, stores, manipulates, analyzes, manages, and presents all types of spatial data, that can be used to evaluate many aspects of healthcare delivery. Nurses have recognized the importance of the environment in improving healthcare outcomes since Florence Nightingale. Nursing research that evaluates environment, should consider geographic awareness. GIS research can be used in quantitative, qualitative and mixed methods research. This paper will explain GIS methods, and their application in qualitative and quantitative research. These methods may be used by nurse scientists for the purposes such as, improving patients' outcomes, examining nursing workforce data, or exploring access to healthcare with a goal of policy change at local, national, or global levels.



*Keywords: Geographic Information System, nursing, concepts, methods*

## Geographic information systems nursing research methods: Concepts, methods, and limitations

As early as 440 B.C., healthcare practitioners acknowledged the importance of awareness to changes in the local environment and how traveling healthcare practitioners should be aware of these changes to improve the outcomes of their patients (Adams, 1886). In the mid-1800s, the profession of nursing was in its infancy and as a progressive thinker, Florence Nightingale identified the important association between environment and health. In her heuristic approach, Nightingale transformed clinical practice which was further enhanced by other nurses including, Clara Barton, Mary Breckenridge, and Margaret Sanger (Lundy & Janes, 2001).

The earliest iterations of spatial analysis in nursing were prompted by the lack of adequate nursing care during World War II (Tombin, 1996). Prior to World War II, women were not allowed to serve as nurses near the battlefield, resulting in significant shortages in the nursing workforce. Expanding the Army Nurse Corps to include women improved outcomes for soldiers (Tombin, 1996). By 1955, nursing faculty were using spatial tools to examine the distance nursing students traveled for clinical experiences in specialty areas (Vreeland, 1955). The first published spatial analysis study in

nursing measured the supply and geographical distribution of Certified Nurse Midwives in the United States (Langwell, Wilson, Deane, Black, & Chui, 1980). Today, several multidisciplinary specialties exist whose goal is to influence healthcare outcomes using spatial analytic tools (Archibald & Putnam Rankin, 2013; Brasil, Gomes, Miosso, da Silva, Amvame-Nze, 2015; Hames, Stoler, Emrich, Tewary, Pandya, 2017).

Nursing research that evaluates environment and its effects on individual health, should consider geographic awareness. Geographical Information Systems (GIS) methods afford researchers the ability to integrate spatial information from a wide range of heterogeneous sources and to precisely measure distance which is plotted into a single framework: data points such as demographics, community resources, healthcare data, distance to the nearest healthcare provider or the amount of green space available in a neighborhood.

Nurse researchers have continued to include environment in nursing studies, but few use GIS to examine the relationships between person and environment. It is likely that GIS methodologies have been underutilized by nursing researchers primarily because these methodologies have a reputation of being purely quantitative, expensive, and difficult to use for persons with

no prior experience (Townley, Kloos, & Wright, 2009). This paper will explain GIS methods, and their application in qualitative and quantitative research. These methods may be used by nurse scientists for various purposes, such as, improving patient outcomes, examining nursing workforce data, or exploring access to healthcare with a goal of policy change at local, national, or global levels.

## Healthcare Access

Healthcare access and barriers have been evaluated by many researchers, and the terminology used remains diverse and inconsistent. For the purposes of this paper, the conceptualization of Penchansky and Thomas (1981) will be used to describe the measures of access acknowledging five dimensions: availability accessibility, affordability, acceptability and accommodation. These five dimensions of healthcare access can be addressed in nursing research using spatial analysis.

Availability is defined by Penchansky and Thomas (1981) as the adequacy of the supply of healthcare providers and facilities, and of specialty programs such as mental health services and emergency care, to the number of patients who have a need for services. When considering

accessibility, researchers examine the spatial distribution of healthcare providers, and how easy it is for patients to reach the healthcare providers (Luo & Wang, 2003). This measure can include quality and character of the healthcare services provided (Handy & Niemeir, 1997). This dimension of access may consider the patient's mode of transportation, travel times, distances, and costs. Accommodation is the manner in which the healthcare providers, facilities or services are organized to provide care to clients. This includes appointment systems, hours of operation, walk-in services, or virtual health and the patient's ability or perceived need to accommodate to these restrictions (Penchansky & Thomas, 1981). Affordability is also considered by Penchansky and Thomas (1981), as important to consider in a country where healthcare is not considered to be a human right and universal access to care does not exist. Affordability considers the relationship of prices of healthcare services, the client's ability to pay and existing healthcare insurance. This dimension also considers the patient's perception of worth relative to the total cost. Finally, acceptability is considered the relationship of the client's attitudes regarding the personal and practice characteristics of healthcare providers, healthcare facilities and healthcare services (Pechansky & Thomas, 1981). Most commonly, this is referred to

as the consumer reaction to healthcare systems, including age, sex and ethnicity of a healthcare provider and type of facility including religious affiliations. Healthcare providers and systems can alternatively consider acceptability when providing care, such as refusing care to Medicaid or Medicare patients or through accommodation making themselves less accessible to these types of patients.

As healthcare delivery continues to evolve, healthcare is now moving outside of traditional office settings, and includes care delivered remotely via telehealth or internet healthcare services. This is now collectively referred to as virtual health (Sensmeier, 2019). A researcher's ability to use spatial analysis beyond simple measures of distance is increasingly important. This paper will highlight both quantitative and qualitative spatial analysis that can be utilized by nurse researchers. When considering quantitative methods of spatial analysis, the dimensions that can be addressed include availability and accessibility. For researchers considering accommodation, affordability, and acceptability qualitative and/or mixed methods of spatial analytics should be considered.

## Data Collection

Spatial data can be accessed from a multitude of data sources containing locational and attribute information of the environment. Primary data constitutes data collected from two possible methods: 1) psychometric data created from the results of surveys of individuals' self-report characteristics of the environment of interest, and/or; 2) ecometric data collected by research observation such as, observations of neighborhoods to record observations or verify retrospective data on the environment. A newer form of psychometric data collected in Web GIS exists, where consumers may interact with the GIS system to input data into a researcher's built environment. The built environment is a map created by researchers that reflects the geographic area of interest, and allows for data submission from consumers or patients. Secondary spatial data is collected from a variety of external sources and includes commercial data (birth or death certificate data, health insurance data), location data (google street view, yellow pages), and administrative data (census data, population measures). When using secondary data, the datasets are generally substantial in size, and often referred to as metadata or 'big data'. Documentation of data management and appropriate choice of spatial measure used is essential to ensure internal

validity and minimize aggregation errors (Apparicio, Abdelmajid, Riva & Shearmur, 2008). Additionally, this is important to influence future researchers, who will inherit the necessary steps and processes, to appropriately manage and interpret future large data.

## Quantitative Methods

To date there are no published studies regarding guidance or comprehensive taxonomy of spatial research, specific to nursing science. Spatial accessibility to healthcare services is accepted and used more frequently in other sciences including medicine (Gesler, 1986), epidemiology (Pfeiffer, 2008) and the social sciences (Darmofal, 2015). When considering quantitative research methodologies, the most commonly used spatial analyses are provider to population ratios, travel impedance to nearest provider or healthcare facility, kernel density models, gravity models, and two step floating catchment area. Many of these methodologies will be reviewed in this paper,

### Provider to Population Ratios (Indicator of Availability)

Provider to population ratios are an analysis of the available supply of healthcare providers for a targeted population within a defined bordered area

(Guagliardo, Ronzio, Cheung, Chacko, & Joseph, 2004). This is the most common spatial analysis tool used in healthcare research, and is relatively easy to use and interpret for policy makers (Jamtsho & Corner, 2014; Makuc, Haglund, Ingram, Kleinman, & Feldman, 1991). Data sources on healthcare provider locations are generally readily available, and this can be completed on a city, county, state, healthcare service area, or country level. The supply reflects healthcare service capacity which include physicians, nurses, nurse practitioners, clinics, hospitals or services. The demand reflects the population within the bordered areas and can be obtained from census data, insurance data or government data that reflects the constituents. This methodology can be utilized to evaluate healthcare utilization or health status of the target population.

When evaluating availability of healthcare services, provider to population ratios are effective in evaluating supply and identifying underserved areas. This methodology has some limitations, as it does not account for patient migration across borders defined by the researcher and verification such as census tracts (Connor, Kralewski, & Hillson, 1994). Provider source data is not always accurate and assumes each physician at a location is working full time (Guagliardo et al., 2004). Additionally, the

larger the geographic area studied the greater the concern for healthcare supply variations within the area of study. These limitations can be avoided by incorporating additional measures of distance or travel time.

### Travel Impedance to Nearest Provider (Indicator of Accessibility and Availability)

The measure of travel impedance for the patient to nearest provider is interconnected with spatial accessibility within a system or bordered geographical area (Delmelle et al., 2013; Mahmud & Aljunid, 2018). Travel impedance is the time or cost it takes for a patient to move from one area to another, most often reflective of travel between home and a healthcare provider's office. Limitations to be considered when using this method include the precision of the patient or population location and the operational definition of the spatial unit defined by the researcher. When data is not specific to identify patient location with precision, often a centroid is used, which is the geographical center of a larger area such has a zip code or census tract. This can lead to aggregation errors, which occur when a single point is used to represent a neighborhood. This in turn represents an aggregation of spatially distributed individuals which can influence the interpretation of the data (Apparicio et al., 2008; Hewko, Smoyer-Tomic,

Hodgson, 2002). When applying the adjustment, the resolution of the analysis decreases. When centroids are used, all patients or healthcare providers within the centroid are identified to be located in the same place. This can be avoided by improving the precision of the patient data, such as using patient street address. When using travel impedance to measure access, there are several assumptions including: 1) patients are traveling in a straight line to receive care, referred to as the Euclidian distance; 2) patients living in urban areas have a large number of healthcare providers available, yet the closest provider may not be used, and; 3) patients living in rural areas use the closest healthcare provider. This methodology can be refined and improved if the researcher combines it with another method of evaluating spatial accessibility, such as travel impedance (accessibility) combined with healthcare provider supply (Guagliardo, 2004).

### Kernel Density Models (Indicator of Availability)

Kernel density models are a measure of availability and calculate the number of patients that can be accommodated by a healthcare provider, healthcare facilities or services in a designated area (Duck-Hye, Goerge, & Mullner, 2006). The models do not take into account travel of patients to

new areas for healthcare and do not estimate time needed for patients to access that healthcare. Kernel density sets boundaries, defined as a service area, around each healthcare provider, facility or service. The boundaries are geographical territories where people reside and these models consider that the benefits obtained from the facility are greater than the cost of access to it (Spencer & Angeles, 2007). In healthcare research and nursing, the use of this methodology has been limited. Nurse researchers recognize that the use of kernel density estimation provides a visual presentation of healthcare provider density thereby identifying provider shortage locations. Limitations to this method when used in urban areas include locations where facilities service areas overlap, healthcare providers or facilities are over or underestimated, and incorrect estimation of a concentration of healthcare opportunities.

### Gravity Models (Indicator of Accessibility and Availability)

Gravity models represent the potential interaction between any population point and all service points within a set distance. This model is a combined indicator of accessibility and availability and was first utilized by researchers in land planning (Hansen, 2007). Gravity models can be used in

both urban and rural settings and provide a good indication of healthcare availability. Overall, this method is not widely used in healthcare research due to its limitations but has been combined with other methods to improve the quality of the data analysis. Additionally, it only models supply and does not demonstrate the demand of healthcare and is a challenging method of spatial analytics for researchers who are not well versed in geographic analytics.

### Two-Step Floating Catchment Area (Indicator of Accessibility and Availability)

The measurement of spatial accessibility may be affected by the quality of the data used. The Two-Step Floating Catchment Area (2SFCA) was created by Luo and Wang, to address this issue with a floating catchment area (Luo & Wang, 2003). The first step in a 2SFCA is to calculate the healthcare provider to population ratio given a reasonable assumption of travel time. Historically, healthcare research used a 30-minute drive or golden hour time as acceptable for patients seeking healthcare. However, drive times to healthcare may vary because of the patients' specialty healthcare needs. Unique populations with higher acuity and healthcare needs may require less travel time to their providers, indicating

that increased concentration of healthcare providers maybe needed in high acuity healthcare situations (Yerramilli & Gomez Fonseco, 2014).

The second step in a 2SFCA analysis creates an accessibility index by summing up all provider to population ratios in the study area. This method provides a visual representation of all the patients who fall outside of the acceptable distance of travel. The spatial accessibility value is assigned to each population and visually represents the number of healthcare options available. Alternatively, the catchments will also highlight areas of inadequacy where the population does not have access to healthcare services in an appropriate travel time. This method addresses the ability of patients to cross geopolitical borders (Luo & Wang, 2003) .

A catchment area that does not demonstrate variability in levels of access on a map is a limitation of 2SFCA. The catchment area assumes that the center of the centroid provides the same access to care as the periphery, and that just over the created geographical border access is non-existent (Bauer, Muller, Bruggmann, & Groneberg, 2018). Recently, researchers have created modified versions of the 2SFCA to address this concern. Some of these modifications include: optimized 2SFCA (Ngui &Apparicio, 2011); commuter based 2SFCA (Fransen, Neutens, De Maeyer, & Deruyter, 2015);

three step floating catchment area (Wan, Zou, & Sternberg, 2012); modified 2SFCA (Langford, Fry, & Higgs, 2012).

## Qualitative Methods

Qualitative GIS studies can enhance geography from a subjective viewpoint, by providing a visualization of non-quantifiable experiences. This provides researchers with a richer understanding of a patient's experiences in everyday life. Additionally, qualitative GIS can decrease the risk for aggregation errors that were a concern in the quantitative methods previously discussed (Hewko et al., 2002; Lee, Vernez-Moudon, Pip-Courbois, 2006). In studies where the spatial unit of analysis (ie. county, state, etc.) is large, aggregation errors can be mitigated using finer resolution units such as the use of qualitative methods. Researcher using mixed methods or strictly qualitative researcher within GIS will have a substantial increase in time required for the data collection and analysis (Lee, 2006). This increase in time may improve the overall generalizability of the data and will help nurse researcher's influence policy change that stems from erroneous results (Hewko et al., 2002).

Qualitative GIS is rapidly expanding and includes the conversion of non-digital information, and provides information on the context and meaning of a situation and processes of interest (Pavlovskaya, 2011). Qualitative GIS refers to a multitude of methodological efforts to incorporate increased amounts of qualitative data into GIS than have traditionally been used. A few methods that have been used include geo-ethnography, feminist visualization, grounded visualization and geo-narrative methods. This can include traditional qualitative methods of obtaining data such as: observations, interviews, and stories. As we move into a more digitally driven society other areas that can be considered include social media posts, tweets, geotagged internet data, global positioning systems tracked movements, and digitally recorded consumer information (Mooney, Corcoran, & Ciepluch, 2013). These can be powerful analytical tools, that when used appropriately in GIS can examine the dimensions of affordability, acceptability and accommodation. This expansion beyond digital information expands the focus of the environment, from a small area surrounding a patient's home, to also include their activity space and chosen transportation (Townley et al., 2009). The use of

qualitative GIS has the potential to improve understanding of the lived patient experience in our current healthcare environment.

## Sociospatial Grounded Theory (Indicator of Acceptability and Accommodation)

Grounded theory is an inductive approach to research that was defined by Glasser and Strauss (1967). Historically, it has been used by nurse researchers to uncover new theoretical knowledge. This is done by immersing themselves, with no preconceived ideas, into the lived environment of interest where the data collection occurs (Reed & Shearer, 2009). The goal of grounded theory is to collect data that creates patterns which can be recognized, and may create new theoretical knowledge. This process is repeated by the researchers until a point of theoretical saturation is noted (Dey, 1999). Where no new themes, patterns or concepts are identified from the data

The inclusion of geographic location and the lived environment can improve the emergence of themes, ideas and relationships in the data, and is referred to in the literature as sociospatial grounded theory (Steinberg & Steinberg, 2006). In order to incorporate grounded theory into GIS, the researcher would select a geographic location of interest such as a

neighborhood, county, or residents of a specific area. The data collection would be completed in a traditional grounded theory method and spatially coded to reflect the geographic location of the data. The combination of qualitative data and location allows the researcher to examine if the physical environment is related to perceptions of the patients seeking healthcare and identify potential geographic patterns that reveal how location plays a role in perception.

### Participant Observation (Indicator of Accommodation)

Participant observation is a research method where researchers actively participate in whatever issue or topic they are studying. This research method allows the researcher to make observations of the participants, as well as, individual perceptions of the lived experience (Steinberg & Steinberg, 2006). For researchers interested in healthcare access, they may be interested in the experience of obtaining healthcare for patients with different forms of insurance. Using GIS, the researcher can examine how patients with different types of insurance obtain care. Additionally, the distance travelled to obtain healthcare services from home or work can be examined and compared. This method has the ability to

highlight inequities in smaller areas of healthcare access. Patients with private insurance generally have a larger selection of options when seeking care, compared to patients who utilize Medicare or Medicaid.

### Geo-Ethnography (Indicator of Accommodation, Acceptability)

Qualitative research that combines GIS and ethnography has been referred to in the literature as geographical ethnography (Matthews, Detwiler, & Burton, 2005). This method allows researchers to evaluate how healthcare disparities are created, by connecting the lived experience on a map with visual representations of data (Smith, 2006). Geo-ethnography provides a mode of inquiry for evaluating the concerns, knowledge and activities of a marginalized group and how those relate to a particular institutional complex. Using geo-ethnography, researchers can investigate the antecedents of patient activities' when seeking care within our complex healthcare system. Thus allowing patients to tell a story that contextualizes and environmentally situates their healthcare experience over time. This method of research reveals the lived activity space and boundaries patients create, as the boundaries often extend beyond the fixed census tracks or neighborhoods used in quantitative methodologies. Additionally, this type of

research can help identify quality improvement issues, based on barriers patients experience when utilizing healthcare. Limitations when using this methodology or others previously mentioned include: the potential risk of missing concepts due to the volume and diversity of the data collected, the relationship of the researcher with the participants, researcher or participant bias, and participants' openness to complete the research while providing an honest interpretation of their lived experience.

## Future Directions

GIS software historically has been inaccessible to the general public, but changes in the platform have more recently allowed for public access to GIS databases. Web GIS is the integration of GIS software and the internet. The movement from a software platform to an internet-based application has made GIS more accessible for researchers and consumers. Shifting visual data to the internet increases the potential for audience engagement, including healthcare consumers.

Researchers implementing Web GIS are often interested in collecting volunteered geographic information (VGI). VGI is digitally spatial data produced voluntarily by healthcare consumers, rather than by healthcare

organizations, institutions, or governments (Dragicevic, 2004). This information can include transportation information, locations of healthcare facilities utilized, lived environment, photos, social media, text messaging and perception (Mooney, Corcoran, & Ciepluch, 2013). Due to the web-based nature of VGI, the data points collected using a personal electronic device are most often geocoded and placed on the map by the healthcare consumer (Saltenberger, Li, Tsou, & Bahramzi, 2015). Additionally, the platform can be used to track patient movement and push SMS or notifications when a patient is in a particular location in order to target specific populations (Ismaeel & Jabar, 2013). This interaction is then examined by the researcher and can be available for public consumption or stored securely for only the researcher to examine.

## Limitations

Limitations beyond what were discussed above and that are applicable to all types of spatial analysis will be reviewed. Researchers who are evaluating spatial access are often working with large data sets that contain state-wide or country-wide information. When working on a local level

finding discrepancies in datasets is not difficult, but when using large datasets, finding discrepancies is extremely difficult and time consuming.

Healthcare providers have become increasingly mobile in recent times (McLafferty 2003). Researchers need to be aware of this when using large datasets of healthcare provider locations. Healthcare providers can now offer virtual healthcare services, may have more than one location and not all healthcare providers work 40 hours a week in the office providing direct patient care (McLafferty, 2003). Large datasets provided from state licensure databases or professional membership datasets may not always reflect practice locations but rather provider mailing or home addresses (Caley, 2004). Healthcare providers can move and change practice locations or specialties (Hewko et al., 2002). Geographical datasets should be comparable in timeframe to the healthcare data they are being compared to. Researchers should avoid using healthcare outcomes data that is 10 years old and comparing it to geographical locations of healthcare providers that are significantly more current. Additionally, the addresses may be incomplete and the decisions should be made whether to exclude incomplete addresses from the dataset or edit them based on research done by the investigator. Overall, the inability to recognize and address these limitations could result

in the misinterpretation of the distribution of healthcare providers and the extent of available services.

It is important for nurse researchers to consider the resolution of the data when designing a study to improve the reliability of the data. For researchers who are evaluating national or state level spatial accessibility, using county level data is appropriate and will provide adequate resolution for appropriate interpretation of the data (Caley, 2004) . When considering spatial access from a county, city or community level, researchers should consider using zip code, census level or street level data.

Finally, spatial access and GIS are novel tools in nursing with limited information related to the reliability and validity of the analysis in nursing science. Future research should focus on improving the utilization of GIS in nursing to improve healthcare outcomes. Increased use of GIS in nursing will lead to further evaluation of the methodology in nursing science. To accomplish this, nurses need to have basic knowledge of spatial analysis tools and work with interdisciplinary scientists to form improved measurement tools. This will lead to increased validity and reliability of the data produced. The development of spatial accessibility methods unique to nursing will aid in furthering the science.

## Conclusions

Historically in the United States researchers using spatial tools to evaluate healthcare adequacy have been limited to quantitative methodologies. This belief that GIS is purely a quantitative tool and the perception that it is too difficult and expensive to use have led to underutilization of GIS. As the healthcare system becomes more challenging to navigate and increasing numbers of healthcare providers are joining large healthcare systems closer to urban areas, nurse researchers have an increased responsibility to demonstrate areas with inadequate access to healthcare. These areas are more often rural, or urban areas with high numbers of minorities or immigrant populations. Qualitative, quantitative and mixed methods spatial accessibility research has the ability to identify areas where discrimination or decreased access has negatively impacted healthcare outcomes. Areas that are identified as a risk should be targeted for intervention. In order for policy change to be successful this research needs to be translated for healthcare workers, policy makers and consumers. GIS methods using a mixed-methods approach has the ability to examine contextual factors that would otherwise be overlooked when using a single method. Nursing students, clinicians, and scientists should be encouraged to

utilize spatial analysis to examine health disparities, health promotion, and disease prevention on local, national and global levels. Nurse scientists should use GIS as a tool to expand on the current level of nursing knowledge and healthcare access. Spatial analysis and GIS should be used to positively impact patient outcomes, healthcare systems, and impact healthcare spending.

In order to influence policy change, nurse scientists must have an increased understanding of how GIS is used appropriately. The ability to translate data to a meaningful format is imperative for influencing policy change. Additionally, consumer involvement and researcher integration of Web-GIS will aid in highlighting not only the need for expanded access for at risk populations but also the perceived need and accommodation of the target population.

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# CHAPTER 4: THE EFFECTS OF GEOGRAPHY ON PRETERM BIRTH RATES AMOUNG THE RESIDENTS OF FLORIDA


## Abstract

*Objective:* To describe the geographical access to prenatal care services in Florida and to examine the relationship between potential access to prenatal care and preterm birth rates.

*Data Sources:* State healthcare provider licensure data and patient level birth certificate data from the Florida Department of Health. Locations of obstetrical care hospitals and birth centers from Florida Agency of Health Care Administration. State level demographic characteristics from the American Community Survey.

*Study Design:* A two-step floating catchment area method was used to calculate geographic prenatal and obstetrical care accessibility for each ZIP Code Tabulation area in Florida. Spatial autocorrelation techniques were utilized to identify areas with decreased access to care during pregnancy and increased rates of preterm birth.

*Data Collection/Extraction:* Geographic accessibility was calculated using ArcGIS Desktop, version 10.6.1. Healthcare provider practice locations and birth facilities were geocoded, using ArcGIS Desktop, by the researchers.

*Principal Findings:* Decreased geographical access to obstetrical care providers and facilities is associated with higher rates of potentially avoidable preterm births, particularly for women who are younger or ethnic minorities.

*Conclusions:* Improved and equitable access to prenatal care and obstetrical services is necessary in Florida to positively impact obstetrical outcomes. The ability to potentially avoid preterm birth by improving access to care could significantly decrease healthcare expenditures for the state of Florida as most women in this study were insured by Medicaid.

*Keywords: Geographic Information Systems, preterm births, two-step floating catchment, obstetrical care, geographical accessibility*

## The Effects of Geography on Preterm Birth Rates among the Residents of Florida.

Compared to the United States, Florida ranks in the top five for the annual number of births per state. In 2016, the state of Florida had a total 225,018 live births (Martin, 2018). Preterm birth is defined as a live birth before 37 completed weeks of pregnancy, and is the leading cause of infant mortality in the United States (American College of Obstetricians and Gynecologist [ACOG], 2013; World Health Organization [WHO], 2010). It is estimated that approximately 75% of perinatal deaths occur in babies born at less than 37 weeks gestational age (Goldenberg & Jobe, 2001). According to the March of Dimes, the state of Florida in 2016 had a preterm birth rate of 10.0% which is above the national average and accounted for approximately 22,000 preterm babies (March of Dimes, 2016). Florida was ranked 45th in the prevention of preterm birth in 2016 (March of Dimes, 2016). The Florida Department of Health, reported that 2.4% of pregnant women who delivered in 2017 did not receive any prenatal care, and 20.3% did not receive prenatal care in the first trimester. Additionally, in 2017, 77% of women had access to prenatal care during the first trimester, approximately 45,000 women did not have access (Florida Department of Health, 2018).

Access to obstetrical care is considered an important means of improving birth outcomes and lowering rates of preterm birth (Van Lerberghe et al., 2014). Studies have consistently shown that women with delays in access to prenatal care or delays in enrollment into the Medicaid system have higher rates of preterm birth (Cox, Zhang, Zotti, & Graham, 2011; Zeitlin, Blondel, & Ananth, 2015). This demonstrates the possibility that there is a protective association between early and adequate prenatal care and positive birth outcomes. Women seeking care in the United States are more often using public health insurance, such as Medicaid. In 2017, the state of Florida provided funding for 55% of all preterm births through Medicaid (Florida Department of Health, 2018). Moreover, the women who are enrolled in Medicaid often live in areas with high poverty rates and therefore are more likely to have higher rates of preterm birth (DeFranco, Lian, Muglia, & Schootman, 2009; Kozhimannil, Casey, Hung, Prasad, & Moscovice, 2016).

The goal of this analysis was to determine the importance of geographic distribution of healthcare providers on preterm birth factors for residents of Florida. Utilization of early and consistent prenatal care has been shown to lower the risk of preterm birth (Van Lerberghe et al., 2014).

Additionally, research has shown that where mothers live during pregnancy can impact healthcare outcomes and has an association with preterm birth (Messer, Kaufman, Dole, Savitz, & Laraia, 2006; O'Campo et al, 2008). In order to aid in the improvement of health outcomes for women and babies, researchers need to identify modifiable risk factors that influence preterm birth and use targeted interventions to lower the risk of delivery before 37 weeks (WHO, 2015).

## Background & Significance

Preterm births are not evenly distributed throughout the United States (Thompson, Goodman, Chang, & Stukel, 2005). Geographical variation in preterm birth rates has been historically poorly explained when researchers examine the distribution of risk factors for preterm birth, including sociodemographic, racial, ethnic, and obstetrical factors. There is limited research examining variations of healthcare access and its influence on preterm birth rates. Utilization of early and adequate prenatal care has been shown to lower the risk of preterm birth (Van Lerberghe et al., 2014). Finally, practice variations among healthcare providers can affect the quality

of care and contribute to delivery outcomes; a modifiable cause of preterm births (Eibich & Ziebarth, 2014).

The use of geospatial patterns to examine or predict health outcomes of resident populations is increasing as a research method (Diez Roux, 2004). Studies that integrate Geographic Information Systems (GIS) analysis into quantitative healthcare research found that living in socioeconomically disadvantaged neighborhoods is associated with increased morbidity and mortality (Braveman et al., 2015; Debbink & Bader, 2011; Messer et al., 2006; O'Campo et al., 2008). Additionally, socioeconomically disadvantaged areas have a notable increase in preterm birth rates and subsequent infant mortality rates (Callaghan et al., 2006; Messer et al., 2006; O'Campo et al., 2008).

Extensive research was conducted to examine determinants of preterm birth, but these determinants remain poorly understood with minimal progress on prevention (Adams, Gavin, & Benedict, 2005). In the United States, limited research exists using GIS to examine determinants of preterm birth. Studies conducted focused on neighborhood conditions and maternal stress and did not examine potential access to healthcare as a variable (Bloch, 2011; Giurgescu et al., 2011, 2017; South et al., 2012).

## Conceptual Model

Andersen's Behavioral Model of Health Services Use is the best known and most commonly used access model in healthcare research (Babitsch, Gohl, & Von Lengerke, 2012). The purpose of his theoretical framework was to reveal conditions that facilitate or impede access and use of healthcare. According to Andersen's theory, access is influenced by three characteristics: predisposing, enabling, and need variables. Predisposing factors are sociocultural characteristics of individuals that exist prior to the need for healthcare (Andersen, 1995). Enabling factors are defined by the logistical aspects of obtaining care, including personal and family influences, as well as the influence of the community and the healthcare resources it provides. Need factors are viewed as the most immediate predictors of healthcare entry into the healthcare system (Andersen, 2008).

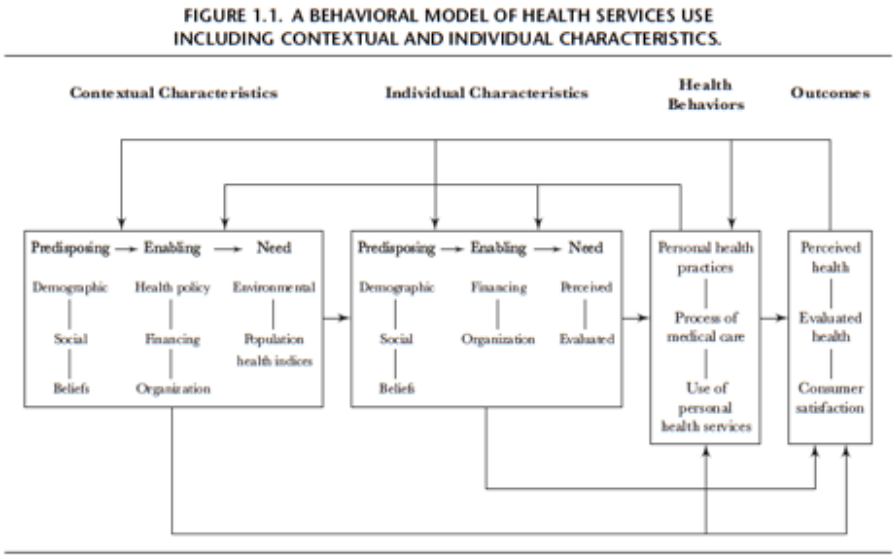


Figure 2: *Andersen Behavioral Model of Healthcare Services Use. Reprinted with permission (Andersen, 2008).*

Andersen further expands the definition of access to include the utilization of personal health services, which makes it imperative for the individual to have social and geographical access to community and personal enabling resources (Babitsch, Gohl, & Von Lengerke, 2012). This is the link that connects the health services and health systems to the populations they serve. Access is not limited to simply receiving a healthcare service but also includes an individual getting the right services at

the right time in order to promote the best healthcare outcomes (Andersen, 2001).

Preterm birth is a potentially avoidable outcome of pregnancy and is linked to limited utilization of prenatal care (Till, Everetts, & Haas, 2015). Routine prenatal care provides the mother and fetus with effective and appropriate screenings, preventative treatments, and timely interventions which improve healthcare outcomes (National Institute of Medicine, 2001). This study was informed by an established model of healthcare utilization. The Andersen Behavioral Model has served as the theoretical framework for studies that conduct GIS spatial methods to examine potential barriers to healthcare, access disparities, patient satisfaction and quality of care (Graves, 2009). According to Aday & Andersen, potential access is the presence of enabling resources and realized access is the actual use of healthcare services (Aday & Andersen, 1974). For women seeking prenatal care in the United States, they face multiple societal barriers that are unique to our healthcare system. In the absence of universal access to healthcare, social structure, health beliefs and enabling resources may determine who uses medical care (Aday & Andersen, 1974).

In this study, healthcare access as defined by Andersen is the ability for women to utilize prenatal care services when and where they are needed (Andersen, 1995). Healthcare decisions are strongly influenced by a woman's local environment and the quality of services available, as well as, ease of traveling and initiating care in a care center (Cromley & McLafferty, 2012). Potential access is the presence of enabling resources, and if limited can lead to a decrease in access to prenatal care services. Barriers such as race, age, poverty level, education, lack of insurance, and geographical location may also predict the utilization of prenatal care. Viewed from this framework, this study describes access to prenatal care services in Florida and examines the relationship between potential access to prenatal care and preterm birth rates.

## Data and Methods

The purpose of this study was to explore the geographical accessibility of prenatal care services in the state of Florida and examine the relationship between potential access to prenatal care and preterm birth rates. Areas with disparities in access with populations of at-risk women may be

identified and targeted for interventions aimed to improve maternal and infant healthcare.

Descriptive GIS Analysis-Research Questions

1. What is the relationship between counts of preterm birth and predisposing characteristics such as: age, race, maternal education level, Women, Infants, & Children (WIC) participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, rural status, ethnicity, and smoking?
2. What is the proportion of women living in Florida within 20 minutes driving time or less to prenatal care, inpatient obstetrical care and emergency obstetrical care?
3. What is the percentage of Florida women within 20 minutes driving time or less to obstetrical healthcare services categorized by age, race, maternal education level, WIC participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, rural status, ethnicity, and smoking to both outpatient, inpatient and emergency prenatal care services?

4. Where are the spatial inequities in potential geographical access located in Florida for women of reproductive age?

Comparative Evaluation-Hypothesis

1. As distance to prenatal care increases in Florida, preterm birth rates will increase while adjusting for age, race, maternal education level, WIC participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, rural status, ethnicity, and smoking, and prior preterm birth.
2. Residing in a rural area will be associated with higher rates of preterm birth as evidenced by women living greater than 20 minutes from an obstetrical service area.

The researcher obtained the data for this research from publicly available datasets. Data on all live births did not include any identifying information. The study was approved by the University of Central Florida Institutional Review Board.

The dependent variable is the number of preterm births among Florida women in a ZIP code tabulation area (ZCTA), which is the smallest level of geography used in this study. The preterm births included in the study were

identified from the Florida Department of Health CHARTS system, a census of births in Florida containing birth certificate data. The researchers screened the data to include all live births before 37 weeks gestation and to remove high risk women from the data, which included: maternal history of gestational or pregestational diabetes, chronic or gestational hypertension, previous preterm delivery, birth occurring outside of a hospital or birth center, twin pregnancy or greater, and birth attendants who were not listed as a Medical Doctor (MD), Doctor of Osteopathy (DO), or Certified Nurse Midwife (CNM).

The birth certificate data was used to construct counts of preterm births for each ZCTA using the maternal ZIP code of residence at the time of the birth. For each maternal ZIP code, a ZCTA centroid was created to use as a marker for maternal location during pregnancy and childbirth. Five years of preterm birth data were combined and accessed through the Florida Department of Health. Finally, ZCTA level preterm birth rates per 1,000 women of childbearing age were calculated, by using the US Census 2013-2017 American Community Survey 5-year estimates.

One independent variable is potential geographical access to prenatal care provider or obstetrical care services. These data were constructed using

healthcare provider practice locations from the Florida Department of Health. The data included MD, DO, and CNM practice locations. Healthcare providers were excluded if they were inactive or expired, had practice locations outside of Florida, and healthcare providers that were not involved in prenatal or obstetrical care. We excluded healthcare providers who provided the following services: reproductive endocrinology, urogynecology, gynecology oncologist and maternal fetal medicine specialist. Prenatal care practice locations were geocoded using ArcGIS. The Florida Agency of Health Care Administration (ACHA) data locations of hospitals and birth centers that provide obstetrical care services, facilities providing obstetrical delivery services were geocoded using ArcGIS. The combination of prenatal care service points and obstetrical delivery service points are referred to as obstetrical care points.

We created a measure of access for each population location following the two-step floating catchment area (2SFCA) method, using the aggregated obstetrical care points data (Luo & Wang, 2003). The benefit to using this method over gravity models, is the ability to measure supply of healthcare providers, compared to the demand (number of patients needing care) and the interaction between the two groups. This method provides a

more realistic measure of potential geographical access, and considers driving obstacles (road closures, dirt roads, lack of private transportation, etc.) and travel impedances (related to cost of travel) which is an improvement over traditional buffer zones.

The first step in the 2SFCA is to calculate the healthcare provider to population ratio given a reasonable assumption of travel time. In this study, we defined each location's catchment area as the distance that can be reached in 20 minutes. Historically, healthcare research has used a 30-minute drive or golden hour time as acceptable for patients seeking healthcare. According to Ravelli et al., the optimal time from home to a healthcare facility for a pregnant woman is 20 minutes, thereby lowering adverse perinatal outcomes (Ravelli et al., 2011). Finally, an accessibility index was created by summing up all provider to population ratios in the study area. This method provides a visual representation of all the patients who fall outside of the acceptable distance of travel. Drive times for each zip code centroid extrapolated from the data set was examined to determine which areas were at highest risk for limited access to care.

To further examine this data set statistically, spatial autocorrelation testing was done in ArcGIS using a Moran's I test. Spatial autocorrelation

measures how close objects are in comparison with other close objects, this provides a visual representation of patients who live in areas where preterm births are clustered, and the risk is high. Alternatively, it provided visualization of the data showing that even in areas with high population, the risk for preterm birth is low. If clustering is found (positive Moran's I), it visually represents a high-risk hot spot area for preterm birth. If the preterm births are evenly disbursed (negative Moran's I), it represents a low-risk, cold spot for preterm birth. The statistical significance for this test is set at the 95% confidence level, with p-values $<0.05$ being considered statistically significant.

The researchers measured predisposing factors and other enabling factors that determine healthcare utilization by several demographic and socioeconomic variables. Demographic measures included in the study were: age, race, ethnicity, maternal education level, WIC participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, and smoking status. US Census socioeconomic data was used to show population density data and identify geographical areas where the majority of the population falls below the federal poverty level.

Florida has 1,240 ZCTA that were included. The ZCTA were used as a proxy for maternal neighborhood, reflecting the maternal living environment at the time of birth. The data included 115 hospitals that provide obstetrical care, four birth centers that are operated by certified nurse midwives, 572 certified nurse midwife offices, and 993 obstetrician offices. These offices and obstetrical facilities made up 1,684 obstetrical care points that were used in the GIS analysis.

## Results

The sample comprised of preterm live births that occurred before 37 weeks gestational age (n=61,327) in the state of Florida between 2013-2017. Births were excluded for the following reasons (maternal history of gestational or pregestational diabetes, chronic or gestational hypertension, previous preterm delivery, birth occurring outside of a hospital or birth center, twin pregnancy or greater, birth attendant that was not an MD, DO or CNM).

Exploratory descriptive data analysis was completed on the maternal characteristics to better understand the demographic makeup of the mothers

including age, race, ethnicity, years of education, smoking status, prenatal care, and maternal insurance, in the study.

Maternal zip code at time of birth was used to identify maternal neighborhood by using the zip code centroid to define where obstetrical care would be obtained if available. Spatial analysis was used to create meaningful visual representations of healthcare access for pregnant mothers through choropleth mapping (shades of color to represent varied intensities of a particular variable).

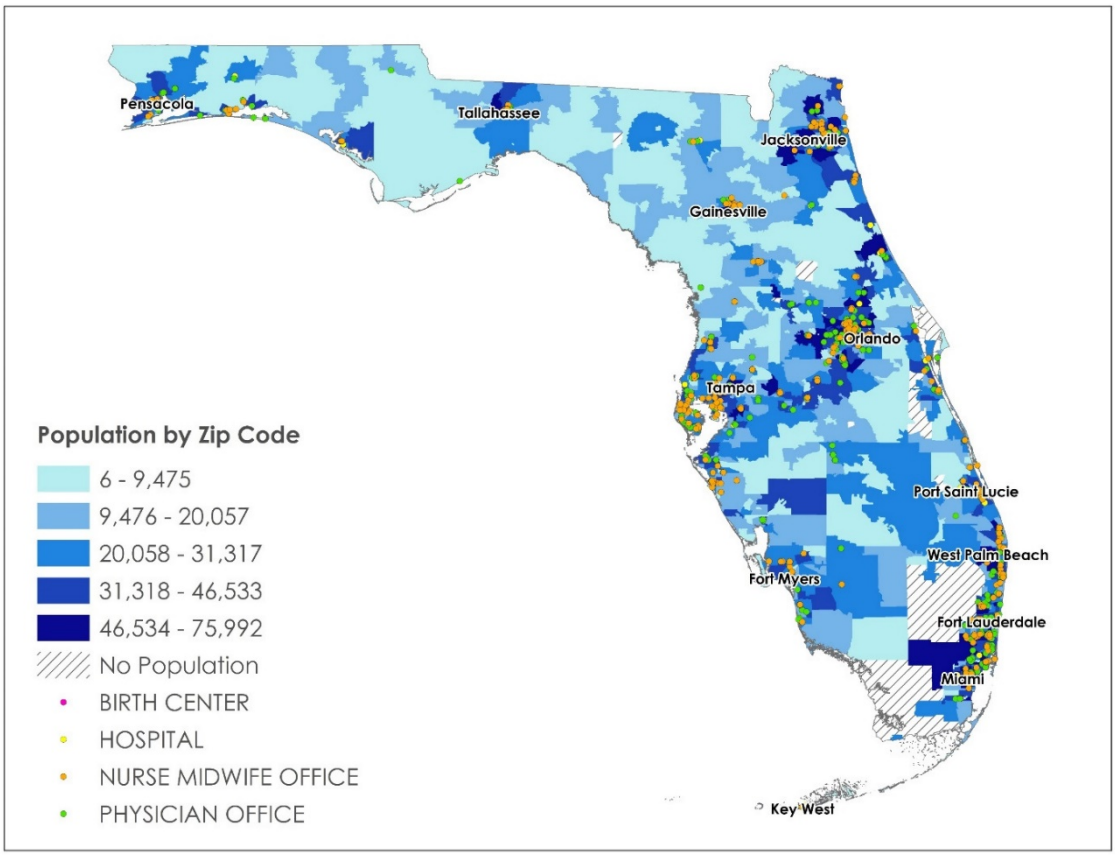


*Figure 3:* State of Florida Distribution of Obstetrical Care Points

Drive time buffers of 20 minutes around each obstetrical care point were created using Esri's ArcGIS Business Analyst. This buffer creates a catchment area that visually demonstrates where obstetrical care services can be received within a 20-minute drive time.

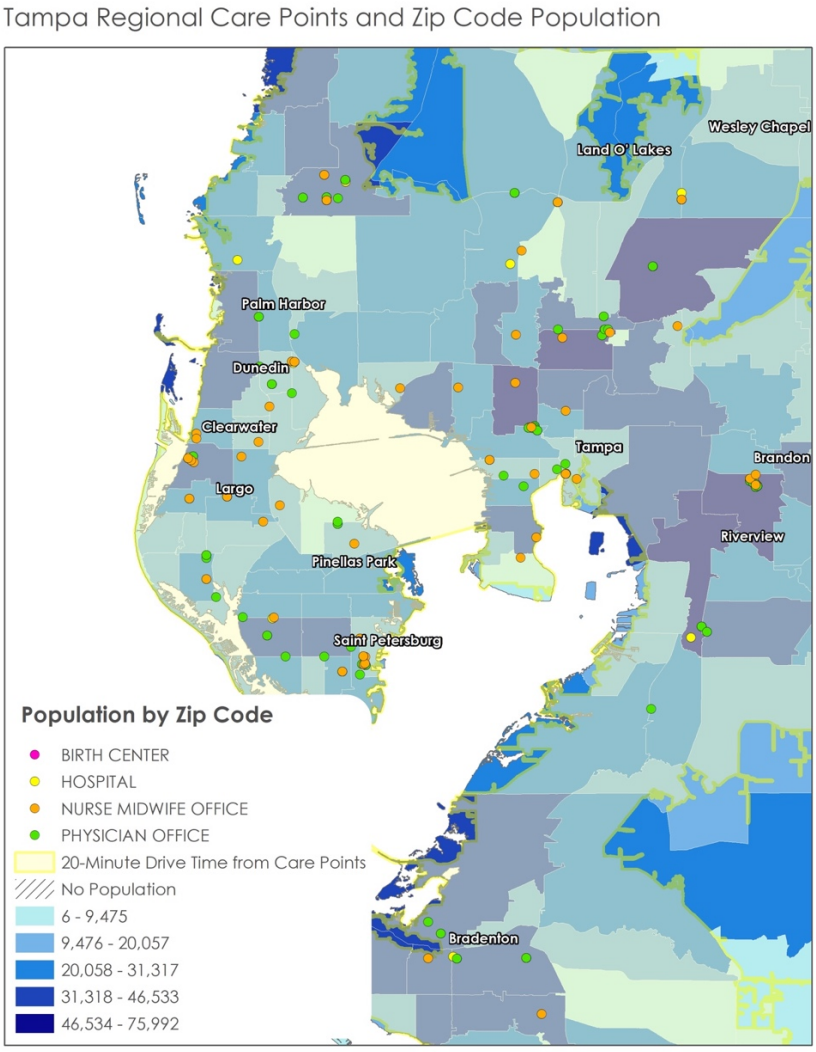


*Figure 4:* Selected example of urban area with <20 minute drive time to an obstetrical care point.

The total combined catchment area for the 1,684 obstetrical care points is 14,968 square miles, which represents only 26% of the total area of the state of Florida. Several areas were identified with high populations of childbearing aged women that fall outside of the drive time catchment, these areas include: Arcadia, Miami, Saint Augustine and Panama City.

Preterm birth data from Florida residents were captured from all 67 counties in Florida from 2013-2017. Of the 61,327 preterm births included in the study, the majority of the women were white (65%), non-Hispanic (68%), with a high school education or greater (82%). Additionally, the majority of the preterm births occurring in this 5-year window were born to mothers who received Medicaid (58%) during pregnancy, and the mothers received WIC services (54%) during pregnancy. Of the mothers included in the dataset, 62% received adequate prenatal care or better and most started prenatal care in the first trimester (65.3%). However, 1 out of 5 births occurred to women who entered prenatal care late, in the fourth month of pregnancy or after. Demographic characteristics of the preterm births are presented in the following table.

*Table 2:* Demographic Characteristics of 61,327 mothers who had preterm birth from 2013-2017 in Florida

| Variable | n | % |
|---|---|---|
| Maternal age, years | | |
| 0-14 | 82 | 0.134 |
| 15-44 | 61,077 | 99.60 |
| >45 | 167 | 0.272 |
| Maternal race | | |
| Black | 17,991 | 29.34 |
| White | 39,570 | 64.52 |
| Other | 3,368 | 5.49 |
| Missing | 397 | 0.65 |
| Maternal ethnicity | | |
| Hispanic | 16,513 | 26.93 |
| Non-Hispanic | 41,734 | 68.05 |
| Haitian | 2,666 | 4.35 |
| Missing | 413 | .67 |
| Maternal years of education | | |
| Less than high school | 9,868 | 16.09 |
| High school graduate or > | 50,317 | 82.05 |
| Missing | 1,141 | 1.86 |
| Maternal smoking status | | |
| Smoking during pregnancy | 5,583 | 9.10 |
| Non-smoker | 55,218 | 90.04 |
| Missing | 525 | 0.86 |
| Maternal prenatal care start, months | | |
| None | 3,112 | 5.07 |
| 1-3 | 40,060 | 65.32 |
| 4-6 | 7,984 | 13.02 |
| 7-9 | 1,711 | 2.79 |
| Missing | 8,459 | 13.79 |
| Maternal WIC | | |
| WIC recipient | 33,235 | 53.79 |
| Not WIC recipient | 28,556 | 46.21 |
| Maternal insurance | | |
| Medicaid/Medicare | 35,281 | 57.53 |
| Private Insurance | 21,437 | 34.96 |
| Self pay | 3,608 | 5.88 |
| Missing | 1,000 | 1.63 |

## Access to Obstetrical Care

The data were evaluated to examine key demographic characteristics for the 20-minute drive catchment area using the U.S. Census 2013-2017 American Community Survey 5-Year Estimates for Census Tracts within Florida. Census tracts were assigned to the catchment areas if the census centroid fell within the drive time area. Individual catchment areas were created for obstetrician-gynecologist offices, nurse midwife offices, birth centers that are operated by CNMs, and hospitals providing obstetrical services. Additionally, a combined catchment was created that reflected a drive time of 20 minutes or less to any of the obstetrical care points.

This analysis demonstrated that 88% of females aged 15-44 in Florida, live within 20 minutes of an obstetrical care point for obstetrical or prenatal care. Just under 500,000 women in the state live greater than 20 minutes' drive to any obstetrical healthcare provider or hospital, and approximately 700,000 women live greater than 20 minutes to the closest obstetrical hospital. The most populous area outside of the catchment is the Villages, which is a community for adults ages 55 and older. The second most populous area outside of the obstetrical care catchment is near Venice and is demonstrated in the following figure.

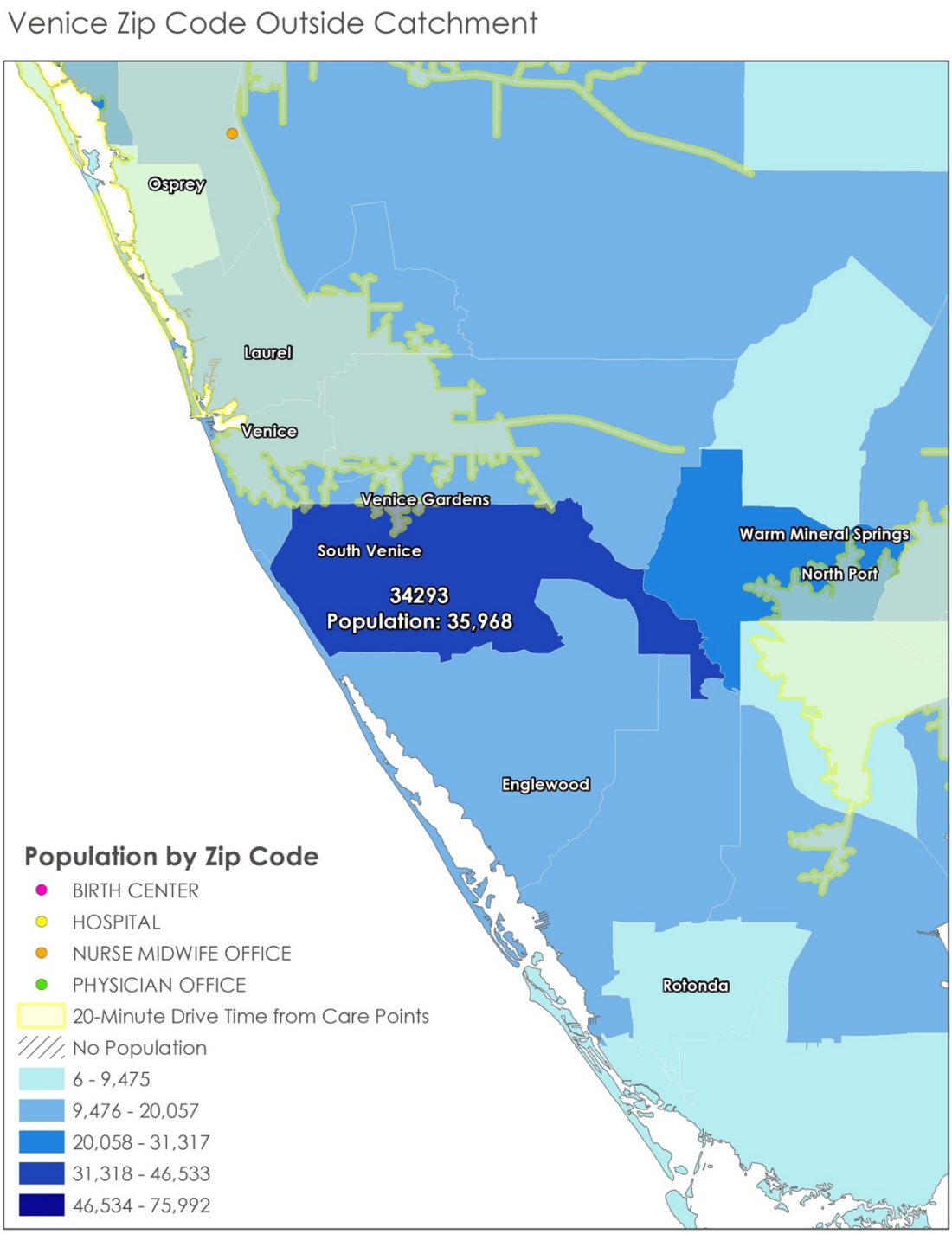


*Figure 5*: Selected example of 2nd most populous zip code outside of 20-minute catchment area

Women living below the poverty line 14% or greater than 400,000 women live outside of the combined catchment, with decreased access to obstetrical healthcare services, see figure below. Additionally, a higher proportion of Black and Hispanic residents had access to care when compared to white residents.

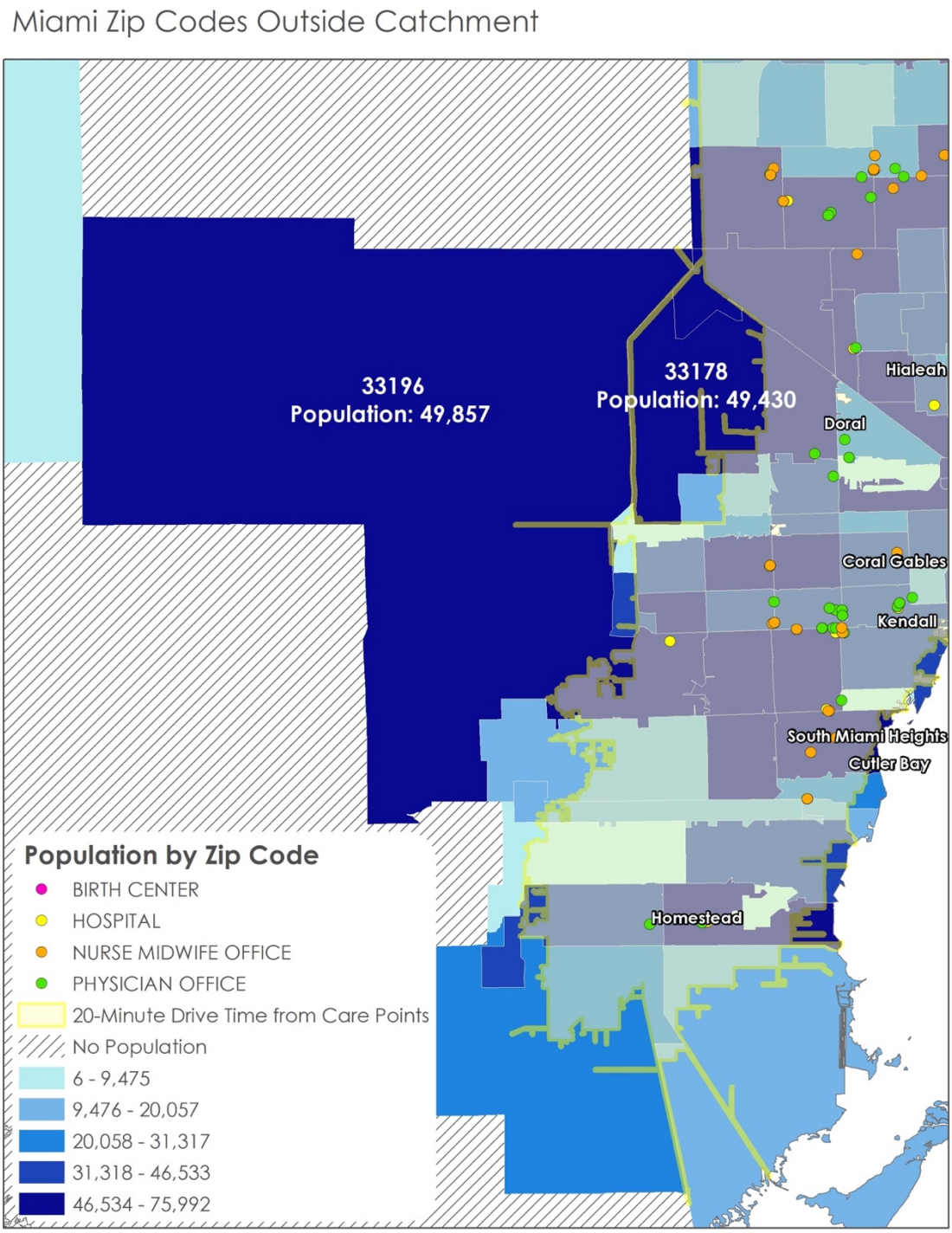


*Figure 6:* Selected area outside of Miami with limited access in rural, low income zip codes

## Preterm Birth Rates

Healthcare provider density was previously noted to be concentrated in areas where large populations of Floridians are living. Women living in rural areas with decreased access to prenatal care and obstetrical emergency services had an increased risk for preterm birth. This was evident when the zip codes with the highest rates of preterm birth were identified. Of the top 10 highest zip codes for preterm birth in this analysis, all of the zip codes fell within the 20-minute combined catchment inferring that the mothers in this area had adequate access to prenatal care and obstetrical care services as delineated in the following figure.

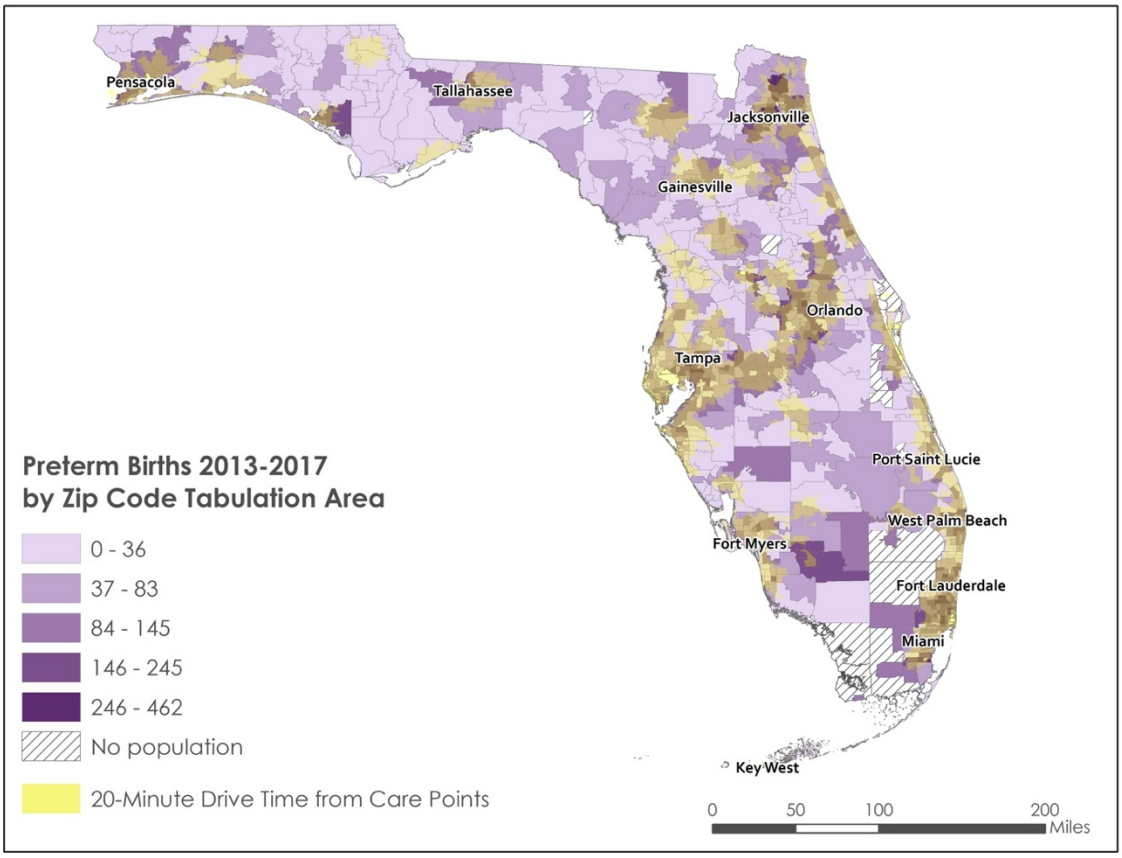


*Figure 7:* Total Preterm Births by Zip Code

To further examine the outcomes in these areas the preterm birth rates were normalized by population to provide a more informative look at the relative geography of preterm births in the state. Of the top 10 zip codes with the highest rates of preterm birth, three quarters of the zip codes fall outside of the 20-minute drive time to any obstetrical care point.

*Table 3:* Top Ten Highest Rates of Preterm Birth by Zip Code

| **Preterm Birth Rates** | | |
|---|---|---|
| Zip Code | City | PTB/1,000 population |
| 32681 | Orange Lake | 20.83 |
| 33521 | Coleman | 17.59 |
| 32356 | Salem | 16.39 |
| 34138 | Chokoloskee | 13.51 |
| 32658 | LaCrosse | 13.00 |
| 32639 | Gulf Hammock | 12.05 |
| 32463 | Wausau | 11.83 |
| 33605 | Tampa | 10.17 |
| 32140 | Florahome | 9.71 |
| 32648 | Horseshoe Beach | 9.24 |

These are areas in the state with low populations and are not closely approximated to urban areas. For women seeking obstetrical care in these areas it is an average of 37 minutes driving time.

Women with longer than 20-minute drive times to obstetrical care points and limited access to care were more likely to be age 0-14, have less education than a high school diploma and were smokers. Overall women who were Black or Haitian, or Hispanic had better access to care than women who identified as white but still had higher overall rates of preterm birth. Small pockets of risk were identified using GIS mapping, for Black women living outside of Tallahassee. Black women living in 4 ZCTAs north of Tallahassee accounted for an average of 75% of all preterm births,

compared to white women in the same areas who accounted for only an average of 21% of the preterm births.

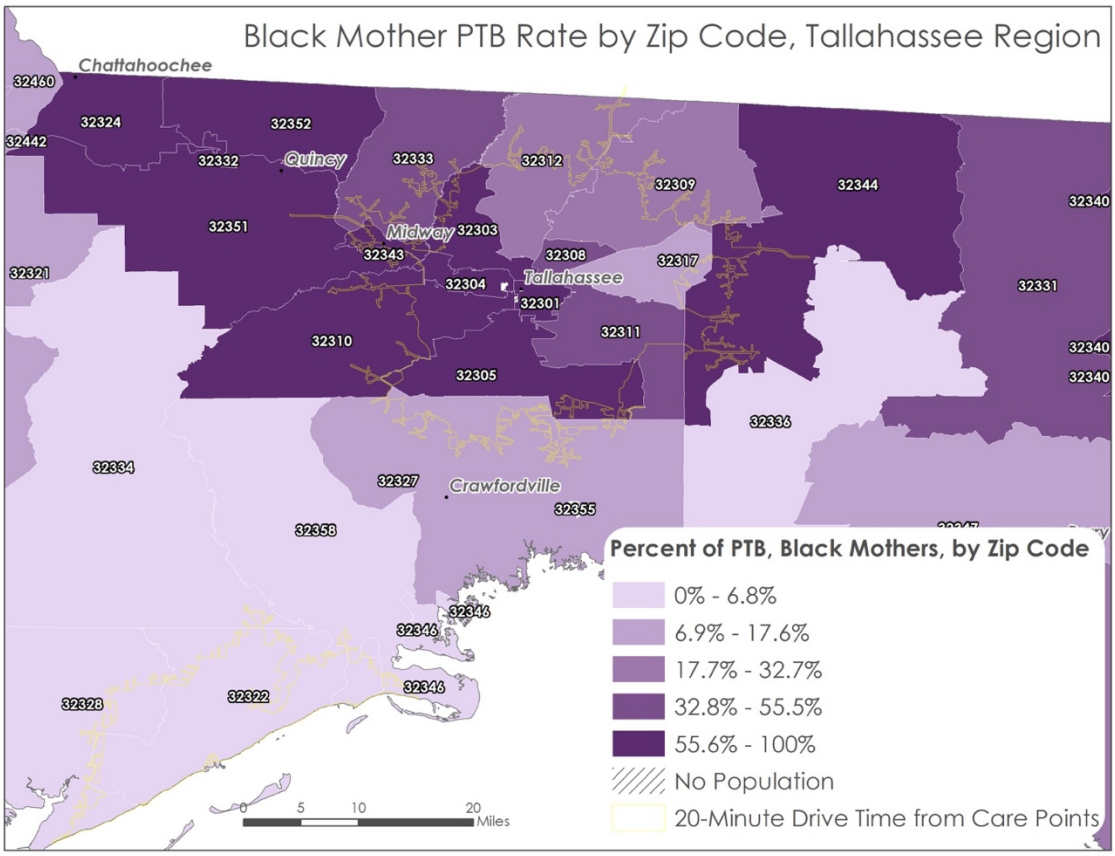


*Figure 8:* Percent of Total Preterm Births, Black Mothers, highest risk zip codes

Additionally, for women living in South Florida who identified as Hispanic, higher rates of PTB were noted in 11 high risk ZCTAs, with Hispanic women making up 68% of all preterm births in these 11 areas.

Finally, racial disparities that were found fell outside of the 20-minute drive time catchment.

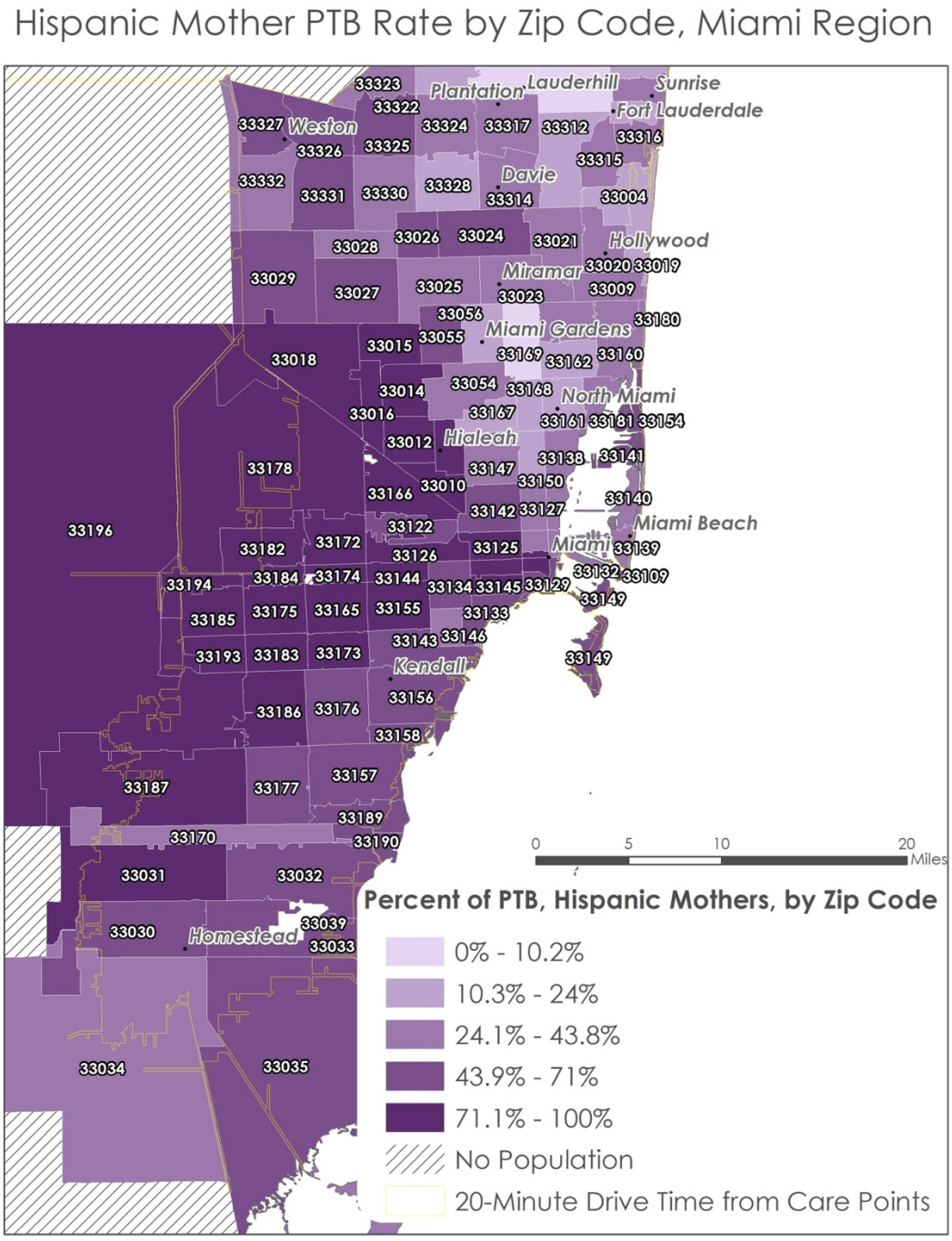


*Figure 9*: Percent of Total Preterm Births, Hispanic Mothers, highest risk zip codes

## Drive Times

The average drive time from the zip code centroid to the nearest obstetrical care point for populations within the catchment area was 9 minutes. For zip codes outside of the catchment area that had at least one resident, the average drive time to an obstetrical care point was 36 minutes. Overall, there were 3,923 preterm births or 6.4% of the study population that occurred outside of the catchment area. When considering the entire state, regardless of catchment area, the average drive time to an obstetrical care point was 14 minutes.

The top 10% of zip codes with the highest rates of PTB outside of the 20-minute catchment were further examined. The areas with high rates of preterm birth combined with a greater than 20-minute drive time to an obstetrical care point had a significantly increased distance to access care.

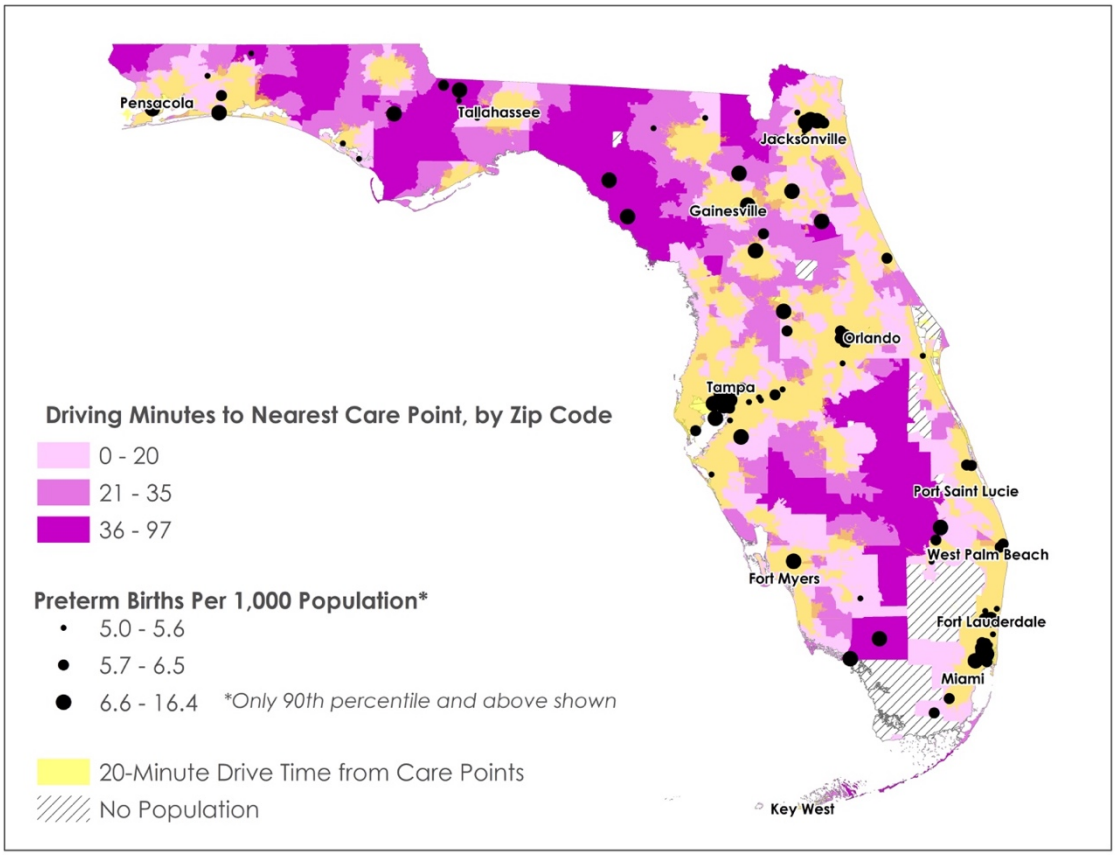


*Figure 10:*Driving minutes to the nearest obstetrical care point and preterm birth rates by zip code

In Dixie County, the town of Horseshoe Beach had a PTB rate of 9.2/1,000 and a drive time of 97 minutes to the closest obstetrical healthcare point. Additional areas of limited obstetrical care access were noted and can be found in the following table.

*Table 4:* Significant Preterm Birth Rates (PTB rate/1,000 population outside of the combined catchment area

| County | City | Zip Code | PTB Rate/1,000 | Driving Time (minutes) |
|---|---|---|---|---|
| Dixie | Horseshoe Beach | 32648 | 9.2 | 97 |
| Taylor | Salem | 32356 | 16.4 | 83 |
| Gadsden | Gretna | 32332 | 8.6 | 42 |
| Collier | Ochopee | 34141 | 7.8 | 36 |

All of the areas identified as having higher rates of PTB were >30 minutes to the closest obstetrical care point; these areas are rural, with low income mothers who migrate out of county to seek care in pregnancy and for delivery.

## Geographical Clustering

Using spatial autocorrelation, geographical clustering was examined. It was revealed that the PTB data when normalized by population, demonstrated significant geographical clustering (p=0.0000) and a Moran's I test was completed to identify the clusters of high and low risk for PTB (p=0.190; z-score 19.382).

A Moran's I statistical analysis was performed and GIS software presented a visual image of the state of Florida with hot and cold spots for PTB. All reported hot and cold spots for PTB were reported and included in

the map if significant ($p<0.05$). The hot spots with higher rates of PTB were found in Panama City, Quincy, Perry, Jacksonville, Palatka, Okeechobee, Gainesville, Hollywood, Miami and Tampa. Additionally, this map provided visual images of the catchment areas and hot spots for PTB outside of the catchment area were noted in Okeechobee, Quincy, and Perry. The lowest rates of PTB were noted in Largo, Sarasota, Cape Coral, Fort Myers, Naples, Boca Raton, Hobe Sound and Palm Bay.

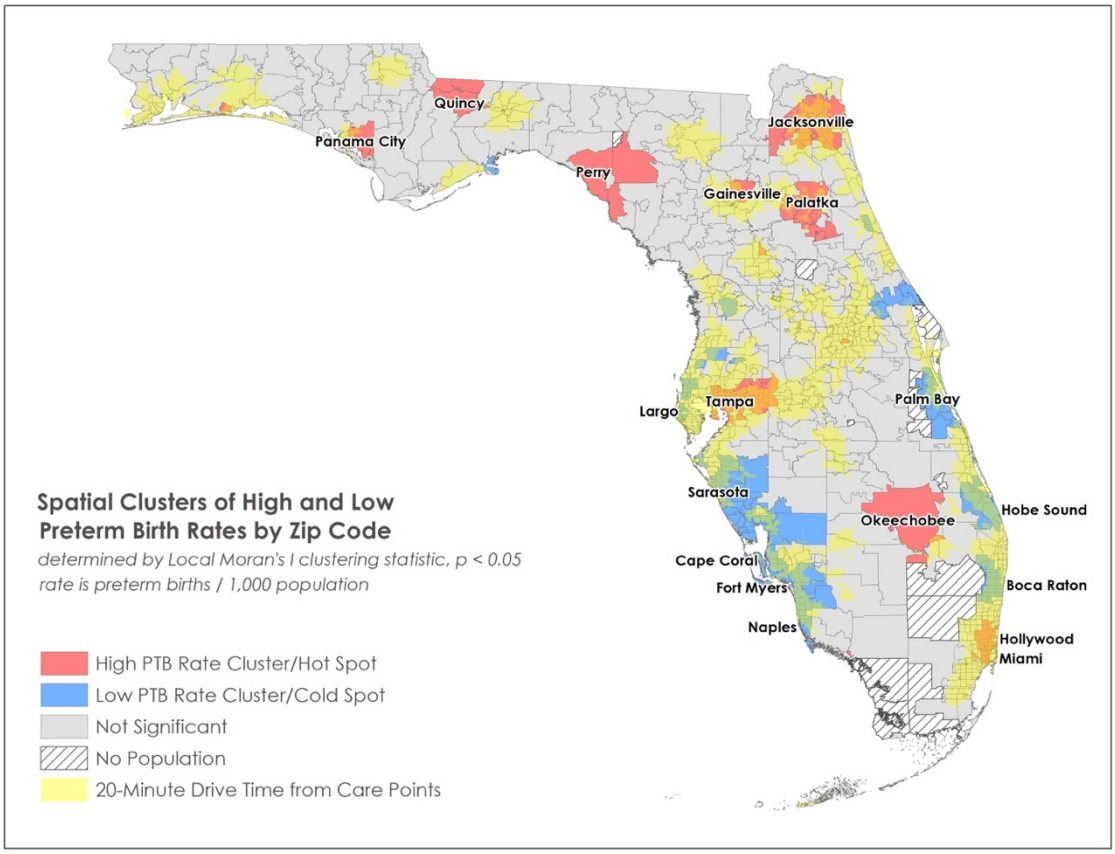


*Figure 11:* Spatial clusters of high and low values for preterm birth rates from a Local Moran's I Test

## Discussion

Pregnant women living in urban areas generally have better access to obstetrical care services when compared to rural areas within Florida. The majority of women in this study had access to obstetrical care services within 20 minutes of their residence, yet our study highlights areas of significant inequity. While 88% of childbearing age women in Florida have access to obstetrical care services, women who identified as Black or Haitian

had the highest levels of PTB in the catchment area. Of those living outside of the 20-minute drive time, over 2 million women or 14% of the population live below the poverty level. Additionally, women living outside the combined catchment were more likely to identify as white. This finding is consistent with the demographic makeup of Florida, whereas women who identify as Black or Hispanic live in the urban areas of Florida.

According to the March of Dimes, the 2018 preterm birth rate for the entire United States was 9.9%. In Florida from 2013-2017 the average yearly preterm birth rate ranged from 9.9 to 10.2% (March of Dimes, 2018). Additionally, the March of Dimes calls for preterm birth rates nationwide to be lower than 9.6% by 2020. The majority of zip codes with the highest rates of preterm birth were outside of the combined catchment area. For women seeking care in these zip codes the average drive time was 37 minutes to the closest obstetrical care point. The spatial analysis identified 3,923 preterm births that occurred outside of the 20-minute drive time to care, 6% of the study population. In Taylor County the rate of PTB was 16.4/1,000 births, with a drive time of 83 minutes to the closest obstetrical care point. Women in parts of Dixie County had to drive an average of 97 minutes to the closest obstetrical care point.

Racial disparities were noted in small pockets in Florida. Black women living outside of Tallahassee had limited access and increased drive times to the nearest obstetrical care point, and had a rate of PTB 3 times higher than the other women in their zip code of residence. Additionally, Hispanic women living in South Florida had higher percentages of preterm birth when compared to other women living in the same areas. These racial disparities highlight a small segment of the racial disparities identified in our healthcare system.

Women living in rural areas outside of the combined catchment, who were noted to have higher rates of preterm birth, included: women who were less than 15 years old at the time of pregnancy, women who smoked, and/or who had less than a high school education. Multicollinearity was noted among the identified risk factors in this study, as noted. These findings indicate that earlier healthcare interactions with the adolescent population on safe sex practices and birth control are needed. Multiple studies have suggested that improved access to birth control for adolescents, has a positive impact on lowering fertility rates and preterm birth rates (Goldthwaite, Duca, Johnson, Ostendorf, & Sheeder, 2015; Ricketts, Klingler, & Schwalberg, 2014). Finally, smoking cessation should be

encouraged for all women as it is a known risk factor for preterm birth in women of all ages. The identification of known modifiable risk factors in this study that increase risk for preterm birth, emphasizes the overall healthcare inequities for women living in Florida. These modifiable risk factors need to be the focus of healthcare providers and policy makers, to lower the overall healthcare disparities for women and babies in the state of Florida.

## Limitations

This study examined potential access to obstetrical care in Florida and does not reflect actual or realized access for women in the study. The researchers understand that women living in areas with exceptional potential accessibility may have additional barriers to realized access, that are not examined here. Additionally, barriers to realized access will have different outcomes and limitations for researchers, even if the same 2SFC method is used.

GIS healthcare research methods have several limitations. Of greatest importance is the quality of the data being used to create spatial analysis. Datasets that are used in GIS healthcare research are large and can contain

inaccurate or missing information. Additionally, the data is cross sectional and limits the researcher's ability to find direct causality in any of the observed patterns.

Another limitation is the inability to precisely identify the maternal point of residence. Birth certificate data that is publicly available provides the maternal zip code of residence at time of birth. This limits researchers when conducting a GIS analysis because even when using the zip code centroid as a point of reference for all mothers living in that zip code, in rural areas this could skew the research results due to significant inaccuracy when compared to where the mother lived. This is also more pronounced in rural areas, which tend to be larger in land mass and population. Comparatively in urban areas it can also skew the data, where a patients defined area where healthcare may be obtained may be larger than what is assumed. Additionally, for migrant or homeless women this does not accurately reflect their residence.

The use of 2SFCA methods in healthcare has several limitations that should be considered. The 2SFCA method assumes that all healthcare providers work the same number of hours, when considering supply needs. Additionally, it assumes that when the healthcare providers are at the

location identified they only provide patient care and do not have any administrative duties. For example, the length of time spent with patients, how many hours per day a provider delivers care, and time spent on administrative responsibilities, cannot be calculated. This can lead to an overestimation of supply when compared to the demand in the community.

Quantitative GIS research also does not consider the means by which a mother would travel when seeking care. Women who live rurally are more likely to utilize car transportation when available. Women living in urban areas, are more likely to walk or use public transportation. All of these options significantly influence how far a pregnant woman can move in 20 minutes when seeking care. Quantitative GIS does not allow for consideration of individual preference in transportation, thus assuming everyone is using a personal vehicle.

## Implications for Practice

This research highlights some areas of Florida with limited access to healthcare services for pregnant women. For the majority of women in this study, Medicaid was the primary payment source for care during pregnancy and is then extended to the neonate at birth. This represents a significant cost

to the state of Florida for pregnancy care, but primarily for care of preterm neonates. Women living outside of the catchment area were more likely to be below the poverty level, smoke, be under the age of 15, with less than a high school education. These women most likely represent a population in Florida with limited access to social resources. Access to the prenatal healthcare system is on average over one hour from where they live. This represents a significance barrier to healthcare access for a vulnerable population of women, who with increased access to prenatal care and social services, may have decreased their risk for preterm birth.

GIS and mapping are becoming increasingly helpful to present visual patterns derived from complex datasets that can often be obscure. In this study, patterns exist between distance to care and maternal healthcare outcomes. The relationships between where a woman lives, how she travels to care, and her individual obstetrical outcome are complex. The combination of quantitative data such as this research when combined with a qualitative viewpoint of how women enter the healthcare system would improve the interpretation and utilization of this type of research in the future.

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# APPENDIX A:

# ACCESS AND UTILIZATION OF PRENATAL CARE IN FLORIDA

Abstract

Prenatal care improves pregnancy outcomes and allows for frequent assessment of the mother. The objective of this study is to describe the geographic access to prenatal care services in Florida and to ascertain the relationship between potential access to prenatal care and preterm birth rates. The purpose of this proposed study is to examine the association between potential access to prenatal care and preterm birth rates among women in Florida. The study will be a descriptive study of a retrospective cohort of all preterm births in Florida from 2013-2017. Geographic information systems (GIS) software will provide an empirical measure of distance and visual identification of areas with decreased access to prenatal care services. Study findings will be disseminated through peer reviewed publications and presentations to increase awareness of healthcare disparities associated with preterm birth and influence policy change to improve healthcare for women and their babies.

*Keywords: Access to prenatal care, geographic information systems (GIS), prenatal care, spatial accessibility, healthcare access, two-step floating catchment area (2SFCA)*

## Introduction

According to the World Health Organization (WHO), the United States (US) poorer maternal outcomes and higher rates of infant mortality when compared to the rest of the industrialized world. Decreases in preterm birth and infant mortality rates are needed to improve overall healthcare outcomes (World Health Organization [WHO], 2015). Preterm birth is defined as a live birth before 37 completed weeks of pregnancy and is the leading cause of infant mortality in the United States (American Congress of Obstetricians and Gynecologist [ACOG], 2013; WHO, 2010). It is estimated that approximately 75% of perinatal deaths occur in babies born at less than 37 weeks' gestational age (Goldenberg & Jobe, 2001).

Preterm births are not evenly distributed throughout the United States (Thompson et al., 2005). Geographic variation in preterm birth rates has been historically poorly explained when researchers evaluate the distribution of risk factors for preterm birth, including sociodemographic, racial, ethnic, and medical/obstetrical factors. There is limited research evaluating variations of healthcare access and its influence on preterm birth rates. Utilization of early and adequate prenatal care has lowered the risk of preterm birth (Van Lerberghe et al., 2014). Finally, practice variations

among healthcare providers can affect the quality of care and contribute to delivery outcomes; a modifiable cause of preterm births (Eibich & Ziebarth, 2014).

The use of geospatial patterns to evaluate or predict health outcomes of resident populations is a more common research method (Diez Roux, 2004). Studies integrating Geographic Information Systems (GIS) analysis into quantitative healthcare research found that living in socioeconomically disadvantaged neighborhoods is associated with increased morbidity and mortality (Braveman et al., 2015; Debbink & Bader, 2011; Messer, Kaufman, Dole, Savitz, & Laraia, 2006; O'Campo et al., 2008). Additionally, socioeconomically disadvantaged areas have a notable increase in preterm birth rates and subsequent infant mortality rates (Callaghan, MacDorman, Rasmussen, Qin, & Lackritz, 2006; Messer et al., 2006); O'Campo et al., 2008). Extensive research was conducted to examine determinants of preterm birth, but these determinants remain poorly understood with minimal progress on prevention (Adams, Gavin, & Benedict, 2005). In the United States, limited research exists using GIS to evaluate determinants of preterm birth. Studies conducted focused on neighborhood conditions and maternal stress and did not evaluate the

potential access to healthcare as a variable (Bloch, 2011; Giurgescu et al., 2012, 2017; South et al., 2012).

The purpose of this study is to explore the geographic accessibility of prenatal care services in the state of Florida and ascertain the relationship between potential access and prenatal care and preterm birth rates. Results of this study may be used to better understand the relationships between preterm birth and potential access for women living in Florida. Areas with disparities in access with populations of at-risk women may be identified and targeted for interventions aimed to improve maternal and infant healthcare.

List 3-5 Objectives for your Proposal

1. To determine the influence of predisposing characteristics such as age, race, maternal education level, WIC participation, delivery payment source, ethnicity, and smoking on preterm birth occurrence and adequacy of prenatal care.
2. To determine what percentage of women live in Florida with potential access to prenatal care, in-patient obstetrical care, and emergency services within 20 minutes of travel.
3. To determine if there are spatial inequities in the Florida

healthcare system that contribute to women receiving less than adequate prenatal care services.

4. To determine if spatial inequities in Florida contribute to increased rates of preterm birth for women living in areas with greater than 20 minutes' travel time to obstetrical care services.

## Background and Significance

Florida ranks in the top five for the annual number of births per state, and in 2016 the state of Florida had 225,018 live births (Martin, et al., 2018). According to the March of Dimes, the state of Florida in 2016 had a preterm birth rate of 10.0% which is above the national average and was ranked 45$^{th}$ in the prevention of preterm birth (March of Dimes, 2016) and accounted for approximately 22,000 preterm babies in 2016. The Florida Department of Health (2018), reported that 2.4% of pregnant women who delivered in 2017 did not receive any prenatal care, and 20.3% did not receive prenatal care in the first trimester. Additionally, while in 2017, 77% of women had access to prenatal care during the first trimester, approximately 45,000 women did not have access (State of Florida, 2018).

Currently, according to the American Congress of Obstetricians and Gynecologist (ACOG) (2014), obstetricians complete the majority of

deliveries, and nurse midwives attend approximately 10% of all births in Florida. In 2014, ACOG published workforce data in Florida and reported 23 of 67 counties did not have a practicing obstetrician (American Congress of Obstetricians and Gynecologist, 2014). Furthermore, these same counties do not have nurse midwifery services because of supervisory state regulations that restrict nurse midwives' expansion into areas where physicians are not practicing. It is well documented that countries who deploy large numbers of midwives to care for low-risk women have consistently demonstrated decreases in maternal morbidity and mortality (Sandall, Soltani, Gates, Shennan, & Devane, 2015). Accessibility to prenatal care that is initiated in the first trimester and adequate throughout the pregnancy was found to lower risk for preterm birth and its sequela (Utz & Halim, 2015).

Prenatal care in the United States historically has not been delivered equitably, and significant healthcare disparities exist among marginalized groups (Cox, Zhang, Zotti, & Graham, 2011; DeFranco, Lian, Muglia, & Schootman, 2009; Nkansah-Amankra, Dhawain, Hussey, & Luchok, 2010; Partridge, Balayla, Holcroft, & Abenhaim, 2012; Whitehead, 2012; Zeitlin, Blondel, & Ananth, 2015). While prior research examined the impact of race

and ethnicity on poor birth outcomes, women who are marginalized by age, poverty level, education level, and payer source struggle to access prenatal care early and consistently during their pregnancy. Early and consistent care in pregnancy improves birth outcomes and postulated that this care allows for the delivery of medical, nutritional and educational interventions at different stages of pregnancy. These interventions allow for preventative care and early intervention that can minimize the risk of complications (Cox et al., 2011; Van Lerberghe et al., 2014). Several theoretical frameworks were used to conceptualize and guide healthcare services research related to prenatal care access and utilization. Andersen's Behavioral Model will be used to frame this study, and its concepts applied to prenatal care access.

The Andersen Behavioral Model served as the theoretical framework for studies that conduct GIS spatial methods to examine potential barriers to healthcare, access disparities, patient satisfaction and quality of care (Graves, 2009). According to Aday & Andersen (1974), potential access is the presence of enabling resources and realized access is the actual use of healthcare services. For women seeking prenatal care in the United States, they face multiple societal barriers that are unique to our healthcare system. In the absence of universal access to healthcare, social structure, health

beliefs and enabling resources may determine who gets medical care (Aday & Andersen, 1974).

Routine prenatal care provides the mother and fetus with effective and appropriate screenings, preventative treatments, and timely interventions which improve healthcare outcomes (National Institute of Medicine, 2001). Currently, the United States health system does not offer universal access to care and current research on the accessibility of care cannot be generalized to other areas of the world. When access to prenatal care is not equally accessible to women with differing resources, the barriers and outcomes these women face will continue to contribute to the overall increasing rates of maternal healthcare disparities in the United States.

The Andersen Behavioral Model has been revised and expanded six times, and the last revision was published in 2001 (Andersen & Davidson, 2001). Andersen's model is the best known and most commonly used access model in healthcare research. The purpose of his theoretical framework was to reveal conditions that facilitate or impede access and use of healthcare.

According to Andersen's theory, access is influenced by three characteristics: predisposing, enabling, and need variables. Predisposing factors are sociocultural characteristics of individuals that exist prior to the

need for healthcare (Andersen, 1995). Enabling factors are defined by the logistical aspects of obtaining care, including personal and family influences, as well as the influence of the community and the healthcare resources it provides. Need factors are viewed as the most immediate cause of healthcare entry into care (Aday & Andersen, 1974).

Andersen further expands the definition of access to include the utilization of personal health services, which makes it imperative for the individual to have social and geographic access to community and personal enabling resources. This is the link that connects the health services and health systems to the populations they serve. Access is not limited to simply receiving a healthcare service but also includes an individual getting the right services at the right time in order to promote the best healthcare outcomes (Andersen & Davidson, 2001).

In this study, healthcare access as defined by Andersen is the ability for women to utilize prenatal care services when and where they are needed (Andersen, 1995). Healthcare decisions are strongly influenced by a woman's local environment and the quality of services available, as well as, ease of traveling and initiating care in a care center (Cromley & McLafferty, 2012). Potential access is the presence of enabling resources, and if limited

can lead to a decrease in access to prenatal care services. Barriers such as race, age, poverty level, education, lack of insurance, and geographic location may also impact the utilization of prenatal care.

## Access to Care

Barriers that affect access to the healthcare system limit a pregnant woman's use of prenatal care. Studies have consistently shown that women with delays in access to prenatal care or delays in enrollment into the Medicaid system have higher rates of preterm birth (Cox et al., 2011; Zeitlin et al., 2015). This demonstrates the possibility that there is a protective association between early and adequate prenatal care and positive birth outcomes. Women seeking care in the United States are more often using public health insurance, such as Medicaid. Moreover, women who are enrolled in Medicaid often live in areas with high poverty rates and therefore are more likely to have higher rates of preterm birth (DeFranco et al., 2009; Kozhimannil, Casey, Hung, Prasad, & Moscovice, 2016).

Late entry to care has been directly related to poor outcomes in the United States (Anum, Retchin, Garland, & Strauss, 2010; Harris, Aboueissa, Baugh, & Sarton, 2015; O'Connell, Zhang, Leguen, & Prince, 2010; Partridge et al., 2012; Zeitlin et al., 2015). This is in part due to shortages of

healthcare providers, particularly primary care providers. Some states also have limited coverage for prenatal care in rural areas, which forces pregnant women to travel long distances for care. Any distance greater than 30 minutes is considered a barrier to access in the United States (Cox et al., 2011; Sparks, 2009). While no studies were conducted in the United States on acceptable travel time from home to hospital for women seeking care in pregnancy, research completed in the Netherlands demonstrated that the travel time should be decreased to 20 minutes to lower the risk of adverse pregnancy outcomes (Ravelli et al., 2011). Research findings on access to care for pregnant women vary based on state scope-of-practice laws for nurse practitioners and certified nurse midwives (Markowitz, Adams & Dunlop, 2016; Traczynski & Udalova, 2013). Harris et al., (2015), found that in Maine, expanding the scope of practice for all APNs significantly improved maternal healthcare outcomes when compared to states with restrictive or supervisory practice (Harris et al., 2015). These findings are consistent with a study conducted in Pennsylvania, a state with restricted APN practice. Poor access to health-promoting services increased poor perinatal outcomes for rural women (Hillemeier, Weisman, Chase, & Dyer, 2007).

The state of Florida is considered to be one of the most restrictive practice states for APNs in the United States, with 26 counties that currently have no access to obstetrical care providers  These counties are at high risk for preterm birth and infant mortality, due to lack of access (DeFranco et al., 2009;  Hillemeier et al., 2007; Nkansah-Amankra et al., 2010; Whitehead, 2012). In one Florida study, mobile prenatal care services were initiated to provide healthcare visits to patients with geographic disparities. This intervention improved prenatal care utilization and birth outcomes by lowering preterm birth rates (O'Connell et al., 2010). Additionally, when geographic disparities are lessened, more women entered care in the first trimester and continued to receive consistent care throughout the pregnancy (Anum et al., 2010; Coley & Aronson, 2013; Cox et al., 2011; Newman et al., 2008; O'Connell et al., 2010). Targeted interventions improved outcomes in rural populations, decreasing disparities in preterm birth and infant mortality.

## Adequacy of Prenatal Care

Eight studies found that early access to care and consistent and regular follow-up throughout the pregnancy were associated with improved birth outcomes (Anum et al., 2010; Healy et al., 2006; O'Connell et al., 2010;

Partridge et al., 2012; Sparks, 2009; Tucker et al., 2015; Whitehead, 2012; Zeitlin et al., 2015). Prenatal care allows delivery of effective and appropriate screening, education, preventative interventions and frequent assessment of pregnancy progression. Multiple studies found that as women participate in greater amounts of prenatal care poor birth outcome rates dropped (Newman et al., 2008; O'Connell et al., 2010; Partridge et al., 2012; Sparks, 2009; Whitehead, 2012). Additionally, studies evaluating the adequacy of care and birth outcomes underscore the importance of early and regular prenatal care. Women who enter care later in pregnancy have increased risk for preterm birth (Whitehead, 2012; Zeitlin et al., 2015).

## Racial Disparities

Racial disparities in preterm birth and infant mortality rates in the United States have been discussed in the literature for many years. African American women are at significant risk for poor perinatal outcomes when compared to non-African American women (Anum et al., 2010; Cox et al., 2011). One study compared perinatal outcomes for racial minorities in the United States and France (Zeitlin et al., 2015). Black women in France were not at increased risk for preterm birth, whereas in the United States the majority of studies identify race as a significant risk factor for preterm birth

and poor perinatal outcomes. African American women have a 47% increased risk of preterm birth when compared to non-African Americans (Anum et al., 2010).

African American women consistently experience disproportionate rates of perinatal and infant mortality when compared to all other races and ethnicities. Racial disparities are still noted in the African American population when prenatal care is delivered appropriately, several studies demonstrated an increased risk for preterm birth for African American women in the absence of late or inadequate prenatal care (Coley & Aronson, 2013; Cox et al., 2011; Healy et al., 2006; Hillemeier et al., 2015; Partridge et al., 2012; Sparks, 2009). Equitable distribution of healthcare services among women of different races is also a concern. Cox et al (2011), found that African American women with medical conditions that complicate pregnancy were twice as likely to receive less than adequate prenatal care when compared with their white peers.

## Research Methods and Design

The proposed study is a descriptive design, which will focus on the State of Florida, which covers 54,242 square miles, 67 counties and 1469 zip codes (State of Florida, 2016). Additionally, approximately 6 million women

of childbearing age, 18-44, reside in Florida (U.S. Census Bureau, 2010). The study will evaluate 133,224 births that occurred in Florida from 2012-2017 resulting in a singleton live birth of a preterm neonate born at <37 weeks' gestational age (Florida Department of Health, 2018). Due to the nature of the data, no personal identifying data was included in the publicly available datasets, therefore no consent is required and an exemption from IRB will be obtained prior to initiation of the study.

## Data Collection

Five principal sources will provide the data for the study: Florida Department of Health (FDOH) FLHealthCHARTS, Florida Agency for Health Care Administration (ACHA), U.S. Census Bureau, Florida Center for Nursing (FCN) and FDOH Practitioner Profiles.

*FLHealthCHARTS:* County birth files containing all preterm births from 2012-2107 will be downloaded. These data include maternal residential zip code and demographic information related to age, race, maternal education level, WIC participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, ethnicity, and smoking status. Women who will be excluded from the dataset are those with a history of prior preterm birth, high-risk pregnancies, and women who carried twins.

*ACHA:* The Florida Agency for Health Care Administration website will be accessed to provide the address and zip codes for all hospitals in Florida that provide obstetrical healthcare services.

*US Census Bureau:* The United States Department of Agriculture Rural-Urban Commuting Area Codes (RUCA) codes will be utilized to provide a zip code approximation of the 2010 RUCA codes. The 2010 RUCA codes are based on the 2010 US Census and provide a measure of population density, urbanization, and daily commuting.

*Florida Center for Nursing:* Workforce data that is collected during licensure renewals for Certified Nurse Midwives (CNM) will be accessed to identify where CNMs are located in the state of Florida. State licensure renewals are completed every 2 years and the data set will provide 2,102 working zip codes for CNMs for the renewal years as follows: 2011, 2013, 2015, and 2017.

*FDOH Practitioner Profiles:* Licensure data will be obtained from FDOH website and the data will be extrapolated to obtain the practice addresses for all MD, DO, ARNP, CNM practitioners in the state of Florida.

## Research Questions and Data Analysis

The datasets will be analyzed by the Principal Investigator with the assistance of a statistician and a GIS expert. The researcher will use both SPSS and ArcGIS Network Analyst extension GIS software for the analysis.

*Independent Variables:* Travel time to healthcare provider (MD, DO, CNM) or obstetrical care center (hospital and CNM birth centers).

*Dependent Variables:* Preterm births (live birth of neonate at <37 weeks' gestational age) and adequacy of prenatal care (initiation into prenatal care <12 weeks AND >8 completed prenatal visits).

Additionally, demographic factors will be analyzed using descriptive statistics and the associations between the demographic factors and preterm birth rates will be examined. These demographic factors will include age, race, maternal education level, WIC participation, delivery payment source, ethnicity, and smoking status.

## Descriptive GIS Analysis-Research Questions

1. Describe the relationship between predisposing characteristics age, race, maternal education level, WIC participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, rural status, ethnicity, and smoking on counts of preterm birth rates.

2. What is the proportion of women living in Florida with potential access to prenatal care, inpatient obstetrical care and emergency obstetrical care within 20 minutes of travel time?
3. What is the percentage of Florida women with access by age, race, maternal education level, WIC participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, rural status, ethnicity, and smoking to both outpatient, inpatient and emergency prenatal care services within 20 minutes of travel time?
4. Where are the spatial inequities in access located in Florida for women of reproductive age?

Comparative Evaluation-Hypothesis

1. As distance to prenatal care increases in Florida, preterm birth rates will increase while adjusting for age, race, maternal education level, WIC participation, trimester prenatal care began, adequacy of prenatal care, delivery payment source, rural status, ethnicity, and smoking, and prior preterm birth.
2. Residing in a rural area will be associated with higher rates of preterm birth as evidenced by higher rates of preterm birth in women living greater than 20 minutes from an obstetrical service area.

## Statistical Analysis

A multivariate model will be used to determine the influence on the independent risk factors on preterm birth and adequacy of prenatal care. Risk factors for preterm birth can occur independently or in combination with other variables. Multiple regression analysis will evaluate the associations and influence of the independent variables (travel time to healthcare provider or obstetrical care center), while controlling for demographic factors, on the dependent variables (preterm births and adequacy of prenatal care).

Additionally, linear regression modeling will be used to assess the effect of distance to healthcare providers or obstetrical care centers on preterm birth rates by zip code. This method will provide a statistical test to determine if increasing distance to a healthcare provider and/or obstetrical care center is associated with higher rates of preterm births in Florida. *Spatial Analysis.* Spatial analysis is a new data analysis tool that remains imperfect but provides valuable information on population health and provides visual tools to identify high-risk populations. Distance and travel time measures have historically been utilized in health services research to measure potential access and are limited as they generally focus on one area

as the primary point of measure (healthcare providers/systems or patients). For the purposes of this study, a method developed by Luo and Wang will be used to conduct spatial analysis with the data (Luo & Wang, 2003). Two-step floating catchment area (2SFCA) will provide a two-step process, including (1) provider to population ratio and (2) population points. The provider to population ratio will be measured by identifying the number of healthcare providers and the number of obstetrical care centers in each zip code and divide that by the number of childbearing-aged women who reside in that centroid. The number will identify areas with high provider density, as well as areas with no evident obstetrical care services or healthcare providers.

In the second phase of the 2SFC, the researchers will identify preterm births in each zip code. Each preterm birth that resides within an area with a 20 minute or less drive time to the closest healthcare provider and/or the closest obstetrical care center will be identified. Acceptable travel times to healthcare services should not be generalized. Historically, healthcare research has used a 30-minute drive or golden hour time as acceptable for patients seeking healthcare. According to Ravelli et al. (2011), the optimal time from home to a healthcare facility for a pregnant woman is 20 minutes,

to lower adverse perinatal outcomes (Ravelli et al., 2011). In GIS research, data themes (preterm birth rates, drive times, etc.) are converted into geographic data layers. Map layers can include roads, political boundaries, census blocks, parcels, zip codes, and research specific data sets can be combined into a functional layer that aids in the evaluation of the dependent variables. Furthermore, each layer is specific to a dependent variable and allows for visualization of geographic disparities when combined. This layering process will provide catchments that visually demonstrate areas with no care, increased drive times to a healthcare provider, or appropriate potential access. The 2SFC analysis will provide each zip code a spatial analysis value which will show supply and demand of obstetrical care services in Florida.

Finally, a Gini index will be utilized to compare the geographic distribution of prenatal care providers throughout Florida. The Gini index is commonly used to analyze the inequality in distribution of healthcare resources. This measurement will identify areas of greatest need by considering the available practitioner to population ratio by zip code throughout the state (Brown, 1994). This will provide further clarity to the

potential need for improved access in the 26 counties with no healthcare provider based on population data.

## Expected Outcome and Potential Impact

The outcome of the study has the potential to demonstrate healthcare inequities within our healthcare system. Additionally, the utilization of GIS technology in healthcare can provide easy to translate visual aids that help to delineate the location(s) of women with the highest need for interventions. These interventions may include deployment of healthcare services to areas with high-risk populations to decrease healthcare cost and improve maternal and neonatal outcomes for the women of Florida and their babies.

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# APPENDIX B: MAPPING THE URBAN PRENATAL CARE EXPERIENCE: CONTEXTUAL FACTORS AFFECTING REALIZED ACCESS TO PRENATAL CARE

Abstract

Early utilization of prenatal care in the first trimester has the ability to positively influence birth outcomes for both women and babies. Geographic Information Systems (GIS) provide researchers with data that can identify targeted populations at increased risk for poor obstetrical outcomes. The use of GIS within qualitative research has been limited and scant literature is available within nursing. This proposal aims to utilize institutional ethnography and GIS to trace the (dis)connection between what women need and what they get from prenatal health care services. The use of ethnography and GIS will contextualize women's perceptions of the community and built environment to better understand their experience in seeking care.

*Keywords: access, utilization, prenatal care, geographic information system, institutional ethnography, preterm birth, infant mortality*

## Introduction

The United States healthcare system is unique when compared to those of much of the developed world because it is not universal. In countries with universal healthcare coverage, women have minimal barriers to utilization of prenatal care and these countries have lower levels of maternal and neonatal morbidity (MacDorman & Mathews, 2009). By contrast, in the United States, prenatal care is a limited resource and even when funded publicly, care is provided in the private sector. This hybrid system negatively influences access to prenatal care for the majority of women in the United States. Furthermore, utilization of prenatal care is influenced by a multitude of maternal, demographic, financial and structural factors. The goal of this research proposal is to use geographic and institutional ethnography to trace the (dis)connection between what people need and what they get from prenatal health services.

## Purpose

The goal of this qualitative research proposal is to better understand the experiences of women seeking prenatal care. Qualitative methods are inductive, which makes them more suitable for understanding people's behaviors, perceptions, and interactions. Research utilizing GIS to evaluate

healthcare has previously been recognized as a positivist tool for storing and analyzing quantitative data. Prior research in women's health utilizing GIS has examined contextual factors that can affect maternal health outcomes, including healthcare access (Okwaraji, Webb, & Edmond, 2015; Gjesfjeld & Jung, 2011) and physical inaccessibility (Vadrevu & Kanjilal, 2016).

Qualitative GIS studies can enhance geography from a deductive and objective science to a more subjective viewpoint, providing a richer understanding of women's experiences in everyday life using ethnography. Institutional ethnography, a research method developed by Dorothy Smith (2006), allows researchers to evaluate how healthcare disparities are created. Institutional ethnography provides a mode of inquiry for evaluating the concerns, knowledge and activities of a marginalized group and how those relate to a particular institutional complex. Using institutional ethnography, researchers can investigate the antecedents of women's activities when seeking prenatal care within our complex healthcare system. Qualitative research that combines GIS and ethnography has been referred to as geographic ethnography in the literature (Matthews, Detwiler, & Burton, 2005).

Andersen's Behavioral Model of Access to Medical Care was utilized to guide this study (Andersen, 1995). The model clarifies realized access as the ability of a woman to use health services. Inequitable access occurs when social structure, health beliefs, and enabling resources determine who gets medical care. Using Andersen's model, the coupling of geographic and institutional ethnography allows for data collection and analysis that is consistent with the framework's dimensions. Using geographic ethnography, a researcher can combine ethnographic data, providing an understanding of family factors, cultural meanings of place(s), and the political and sociocultural influences on the day-to-day lives of women seeking prenatal care. Geographic ethnography allows for better understanding of resources and social networks available to low-income women in a specific community, as well as their ability to use these resources. Institutional ethnography seeks to better understand the woman's experience within a social structure, healthcare system or neighborhood.

Completion of this research will provide answers to the following questions:

- Are low-income mothers' everyday health decisions to access prenatal care influenced by their neighborhood?

- How do low-income mothers understand and negotiate their experiences of poverty, their low-income urban neighborhood and health?
- What influences women to take part in prenatal care during the first trimester?
- What barriers do women believe influence their ability to establish care in the clinic of their choice during the first trimester?
- Do distance, neighborhood geography, and daily responsibilities influence a woman's ability to enter into care in the first trimester?
- What are critical factors that contribute to access to prenatal care?

## Background and Significance

According to the World Health Organization (WHO), the United States maternal and infant mortality rates when compared to the rest of the industrialized world are lagging (2015). Preterm birth (PTB) is defined as a live birth before 37 completed weeks of pregnancy, and is the leading cause of infant mortality in the United States according to the WHO (2015). It is estimated that approximately 75% of perinatal deaths occur in babies born at less than 37 weeks gestational age (Goldenberg & Jobe, 2001). WHO and the Centers for Disease Control and Prevention (CDC) have called for an increase in access to early and comprehensive prenatal care as a means of

reducing maternal and infant mortality (World Health Organization, 2015; Centers for Disease Control and Prevention, 2008).

The United States ranks 61st globally for maternal health outcomes—the lowest ranking developed country (WHO, 2015). The United States preterm birth rate was 9.6% in 2015, and is among the worst of high-resource countries (March of Dimes, 2015). It is estimated that care of premature infant's costs the US 12.7 billion dollars annually (March of Dimes, 2015). Furthermore, preterm births are not evenly distributed throughout the United States with areas of significant healthcare disparities (Thompson, Goodman, Chang, & Stukel, 2005).

Access to early and adequate prenatal care has been statistically shown to improve maternal and neonatal birth outcomes (Loftus, Stewart, Hensley, Enquobahrie, & Hawes, 2015; Partridge, Balayla, Holcroft, &Abenhaim, 2012). According to the State of Florida Office of Vital Statistics, Jacksonville has the highest rates of preterm birth in the state. Women who become pregnant in Duval County are approximately 9% more likely to receive inadequate and late care. The affect of late and inadequate prenatal care is demonstrated by high rates of preterm birth, maternal mortality and infant mortality. Neonates born to mothers residing in Duval

County are 30% more likely to die in their first year of life, compared with neonates throughout Florida (Florida Charts, 2016).

## Design and Methods

Ethnographic research is usually completed during a series of interviews that occur over time. For purposes of this study the researchers will meet with the participants in a series of interviews and develop a relationship with each woman to better understand the lived experience of seeking care in an urban area as a low-income pregnant woman. Additionally, the researcher will attempt to walk with the woman through her daily routines and visualize how entry into the healthcare system is defined within her geographic area. This will allow for the development of trust and a relationship that will improve the understanding of the lived experience for each woman.

## Sample

According to the 2010 US Census, the city of Jacksonville has the largest population in the state of Florida (US Census Data, 2010). Jacksonville, located in Duval County, has the highest rates of preterm birth in the state (March of Dimes, 2015). A small purposeful sample of up to 20

women will be selected from urban areas within Duval County. Women will be recruited at Medicaid enrollment sites, where women go to apply for Medicaid after recognizing they are pregnant. To be included in this proposed research women will have to have had a prior live birth between 2013-2015 of a preterm infant. The researchers plan to interview and collect data from 10 women who are low income, received Medicaid services, lived in an urban area and have had a previous low birthweight preterm infant. The researchers will interview up to 20 women to accommodate for potential drop-out from the research prior to the walkabout and completion of the final interview. Women will be compensated for their time by receiving a gift card for $25.00 after each interview. Additionally, women will be incentivized to complete the three interviews and the walkabout by being offered a bonus gift card worth $25.00. The researchers plan to continue the research until 10 women have completed the series of three interviews and participated in a walkabout with the researcher.

## Data Collection

After consent is obtained, study participants will be interviewed three times. At the first interview, women will be asked about their experiences in

seeking prenatal care as well as the activities and neighborhood environments in which they participated.

Interview guide for first interview

- Can you describe the area you consider to be your neighborhood or community?
- Could you describe a typical day in your neighborhood or community?
- What types of activities or tasks do you complete and are they difficult or easy?
- What resources within your community do you utilize and where are they located?
- Can you describe your transportation method(s)?
- How long have you known you were pregnant and what steps have you taken to establish care for this pregnancy?
- Where do you plan to seek prenatal care and how did you choose the healthcare provider?
- Can you draw me a map of your neighborhood or community and describe all places of interest?

Participants will also be asked to complete an activity called participatory mapping. This method allows women to identify their own

physical boundaries and important resources within their neighborhood and community. This will allow the researcher to better understand what resources, activities, and social services are the most important to the women. Additionally, women will be able to define their communities based on their own unique experiences and perceptions of belonging within the community, as well as their intrinsic motivation to seek out healthcare. The women will not be asked to participate in a walkabout until after the second interview, to build rapport and trust with the researcher.

During the second interview women will be asked follow-up questions based on information from the first interview that may need clarification to ensure clarity when transcribing community information into the GIS. Participants will also be asked if they are willing to participate in a walkabout where they will take the researcher on a guided tour of their neighborhood, important locations, and healthcare centers. The researcher and participant will use the woman's normal mode of transportation throughout the community. This will allow for a better understanding of neighborhood experiences from the woman's perspective rather than assuming what her experience may have been. Walkabouts with participants will provide the researcher with a greater understanding of barriers to

realized access and how social structure, health beliefs and resource influence women's decision-making processes.

The third interview will focus on perception of neighborhood factors, prenatal care satisfaction, and perception of importance of care. The researcher will ask the participants open-ended questions to gain further understanding of their perception of accessibility and prenatal care satisfaction.

Interview guide for the third interview

- Tell me about your experience of entering into the healthcare system once you recognized you were pregnant? What barriers to entering prenatal care do you believe are prevalent in your community?
- How did you choose the location of your healthcare provider for this pregnancy?
- Tell me about your prenatal care experience? If you already have had your baby, please tell me about your care from your first visit until your postpartum care appointments?
- How satisfied are you with the care that you received during this pregnancy?

- Could you describe the most challenging part of receiving healthcare during your pregnancy and explain how you dealt with that challenge?

## Data Analysis

The data collected during the interviews will be transcribed and processed by the researcher. The data to be analyzed come from a diverse set of data collection strategies (observations, field notes, interviews, maps). Consistent with an inductive approach to qualitative research, the researcher will concurrently collect and analyze the data. The researcher will code and identify antecedents throughout the interview process. Institutional ethnography aims to understand people not as the subject of the analysis but as an entry point into understanding the organizational process of seeking care. In order to be mindful of this goal the researchers aim to concurrently process the data to add to identify themes and antecedents to seeking care.

In order for the participant's maps to be used in GIS the addresses will need to be geocoded. This process requires the researcher to change addresses into longitude and latitude coordinates. This will be accomplished by using Google Maps and the information provided from the first interview transcripts. The addresses will be geocoded using the free service at www.batchgeocode.com. The geocoded maps will be entered into GIS and

provided to the participants at the second interview to ensure accuracy of the transcribed information.

Finally, the walkabout will also be geocoded and activity spaces for each participant will be created using GIS in the standard deviational ellipse method. This will provide the researchers with a map showing the general distribution of points in each participant's activity space or neighborhood. This method allows the researchers to identify individual access or opportunity within a community. The researchers will create a measurable activity space for each participant that can be compared to satisfaction data to uncover potentially interesting relationships between psychosocial values, as well as perception of integration.

## Study Limitations

The most serious validity threats within my proposed study are researcher bias, descriptive validity and interpretation validity. Descriptive validity is a concern when performing interviews to gather data. The ability of the researcher to adequately describe the interactions and responses from women could be a concern. Often interviews are recorded using audiotapes and then transcribed onto paper to be later coded and conceptualized by the researcher. This process excludes all nonverbal communications from the

coding process. This is a concern because often nonverbal communication influences how people interpret and respond to others.

Interpretation validity refers to the ability of the researcher to effectively ask questions that elicit meaningful, comprehensive responses. Additionally, the researcher should not try to impose his or her opinion into the interview process, and should avoid all directional questions. The questions the researcher uses need to be appropriate for the specific targeted population, clearly written at a level that is not confusing to interviewees. Cultural competency is also important when asking women about barriers to utilization of prenatal care in the first trimester. Women from other cultures or societies may not share the same concerns.

All researchers have some level of bias; this can be as simple as promoting one idea over another while interviewing women. Often critiques of research may identify concerns of racial, ethnic, gender linked or cultural bias that the researcher did not recognize. It is important that researchers identify all possible bias prior to the start of interviews, and address how they took care of individual biases to ensure they will not influence the study findings.

To minimize validity threats in this study, the researchers will ask permission to videotape the interviews. For women who agree to participate in a walkabout, the researchers will use GPS tracking and timing devices to ensure accuracy of the data that will be geocoded. The walkabout will also be audiotaped. These methods will minimize any validity concerns of the collected data.

## Conclusion

Although most women in the United States do access prenatal care services at some point in their pregnancy, this study aims to identify what connects them to these services. The use of institutional ethnography and GIS will identify barriers that impact how much and when women utilize the prenatal care system in Duval County. Furthermore, inequalities in the distribution of access will be noted using geographic mapping to identify physical barriers to care. The use of GIS will provide researchers, clinicians and health policy professionals with areas that are high risk for late or inadequate prenatal care and increased rates of morbidity. Areas identified as high risk can later be targeted to reduce healthcare disparities by improving the accessibility of healthcare for these women. Overall, this research aims to improve access

and utilization for women seeking care during pregnancy to improve the overall health of women and babies within our communities.

## References


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# APPENDIX C:

# INSTITUTIONAL REVIEW BOARD APPROVAL

UNIVERSITY OF CENTRAL FLORIDA

**Institutional Review Board**
FWA00000351
IRB00001138
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

NOT HUMAN RESEARCH DETERMINATION

March 6, 2019

Dear Corinne Audette:

On 3/6/2019, the IRB reviewed the following protocol:

| | |
|---|---|
| Type of Review: | Initial Study |
| Title of Study: | Access and Utilization of Prenatal Care in Florida and its Influence on Preterm Birth. |
| Investigator: | Corinne Audette |
| IRB ID: | STUDY00000194 |
| Funding: | None |
| Grant ID: | None |
| IND, IDE, or HDE: | None |
| Documents Reviewed: | • Audette_irb_HRP-503_V3, Category: Faculty Research Approval;<br>• Audette-HRP250-V2, Category: IRB Protocol; |

The IRB determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.

IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities are research involving human in which the organization is engaged, please submit a new request to the IRB for a determination. You can create a modification by clicking **Create Modification / CR** within the study.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Adrienne Showman
Designated Reviewer

# APPENDIX D:

# CERTIFICATES OF CONTINUING EDUCATION FOR THE PROTECTION OF HUMAN SUBJECTS

# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 1 OF 2
## COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: Corinne Audette (ID: 4761624)
- Institution Affiliation: University of Central Florida (ID: 405)
- Institution Email: Corinne.Audette@ucf.edu
- Institution Unit: Nursing
- Phone: 6155169248

- Curriculum Group: Human Research
- Course Learner Group: Human Subjects Research- Group 2:Social / Behavioral Research Investigators and Key Personnel
- Stage: Stage 2 - Refresher Course

- Record ID: 25879460
- Completion Date: 22-Feb-2018
- Expiration Date: 21-Feb-2021
- Minimum Passing: 75
- Reported Score*: 100

| REQUIRED AND ELECTIVE MODULES ONLY | DATE COMPLETED | SCORE |
|---|---|---|
| SBE Refresher 1 – Defining Research with Human Subjects (ID: 15029) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Privacy and Confidentiality (ID: 15035) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Assessing Risk (ID: 15034) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Research with Children (ID: 15036) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – International Research (ID: 15028) | 22-Feb-2018 | 2/2 (100%) |
| Biomed Refresher 1 - Instructions (ID: 960) | 22-Feb-2018 | No Quiz |
| SBE Refresher 1 – History and Ethical Principles (ID: 936) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Federal Regulations for Protecting Research Subjects (ID: 937) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Informed Consent (ID: 938) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Research with Prisoners (ID: 939) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Research in Educational Settings (ID: 940) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 - Instructions (ID: 943) | 22-Feb-2018 | No Quiz |

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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Collaborative Institutional Training Initiative (CITI Program)
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Phone: 888-529-5929
Web: https://www.citiprogram.org

# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 2 OF 2
## COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Corinne Audette (ID: 4761624)
- **Institution Affiliation:** University of Central Florida (ID: 405)
- **Institution Email:** Corinne.Audette@ucf.edu
- **Institution Unit:** Nursing
- **Phone:** 6155169248

- **Curriculum Group:** Human Research
- **Course Learner Group:** Human Subjects Research- Group 2.Social / Behavioral Research Investigators and Key Personnel
- **Stage:** Stage 2 - Refresher Course

- **Record ID:** 25879460
- **Report Date:** 11-Oct-2019
- **Current Score**:** 100

| REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES | MOST RECENT | SCORE |
|---|---|---|
| SBE Refresher 1 - Instructions (ID: 943) | 22-Feb-2018 | No Quiz |
| Biomed Refresher 1 - Instructions (ID: 960) | 22-Feb-2018 | No Quiz |
| SBE Refresher 1 – History and Ethical Principles (ID: 936) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Federal Regulations for Protecting Research Subjects (ID: 937) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Defining Research with Human Subjects (ID: 15029) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Informed Consent (ID: 938) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Assessing Risk (ID: 15034) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Privacy and Confidentiality (ID: 15035) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Research with Prisoners (ID: 939) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Research with Children (ID: 15036) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – Research in Educational Settings (ID: 940) | 22-Feb-2018 | 2/2 (100%) |
| SBE Refresher 1 – International Research (ID: 15028) | 22-Feb-2018 | 2/2 (100%) |

**For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.**

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# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 1 OF 2
## COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: Corinne Audette (ID: 4761624)
- Institution Affiliation: University of Central Florida (ID: 405)
- Institution Email: Corinne.Audette@ucf.edu
- Institution Unit: Nursing
- Phone: 6155169248

- Curriculum Group: Biomedical Responsible Conduct of Research
- Course Learner Group: Same as Curriculum Group
- Stage: Stage 2 - RCR Refresher
- Description: This course is for investigators, staff and students with an interest or focus in Biomedical Research. This course contains text, embedded case studies AND quizzes.

- Record ID: 26285872
- Completion Date: 22-Feb-2018
- Expiration Date: 21-Feb-2021
- Minimum Passing: 80
- Reported Score*: 98

| REQUIRED AND ELECTIVE MODULES ONLY | DATE COMPLETED | SCORE |
|---|---|---|
| Authorship (RCR-Refresher) (ID: 15661) | 22-Feb-2018 | 5/5 (100%) |
| Collaborative Research (RCR-Refresher) (ID: 15662) | 22-Feb-2018 | 5/5 (100%) |
| Conflicts of Interest (RCR-Refresher) (ID: 15663) | 22-Feb-2018 | 5/5 (100%) |
| Data Management (RCR-Refresher) (ID: 15664) | 22-Feb-2018 | 5/5 (100%) |
| Peer Review (RCR-Refresher) (ID: 15665) | 22-Feb-2018 | 5/5 (100%) |
| Research Misconduct (RCR-Refresher) (ID: 15666) | 22-Feb-2018 | 5/5 (100%) |
| Mentoring (RCR-Refresher) (ID: 15667) | 22-Feb-2018 | 5/5 (100%) |
| Research Involving Human Subjects (RCR-Refresher) (ID: 15668) | 22-Feb-2018 | 4/5 (80%) |

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 2 OF 2
## COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Corinne Audette (ID: 4761624)
- **Institution Affiliation:** University of Central Florida (ID: 405)
- **Institution Email:** Corinne.Audette@ucf.edu
- **Institution Unit:** Nursing
- **Phone:** 6155169248

- **Curriculum Group:** Biomedical Responsible Conduct of Research
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 2 - RCR Refresher
- **Description:** This course is for investigators, staff and students with an interest or focus in **Biomedical Research**. This course contains text, embedded case studies AND quizzes.

- **Record ID:** 26285872
- **Report Date:** 11-Oct-2019
- **Current Score**:** 98

| REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES | MOST RECENT | SCORE |
|---|---|---|
| Authorship (RCR-Refresher) (ID: 15661) | 22-Feb-2018 | 5/5 (100%) |
| Collaborative Research (RCR-Refresher) (ID: 15662) | 22-Feb-2018 | 5/5 (100%) |
| Research Involving Human Subjects (RCR-Refresher) (ID: 15668) | 22-Feb-2018 | 4/5 (80%) |
| Conflicts of Interest (RCR-Refresher) (ID: 15663) | 22-Feb-2018 | 5/5 (100%) |
| Data Management (RCR-Refresher) (ID: 15664) | 22-Feb-2018 | 5/5 (100%) |
| Peer Review (RCR-Refresher) (ID: 15665) | 22-Feb-2018 | 5/5 (100%) |
| Research Misconduct (RCR-Refresher) (ID: 15666) | 22-Feb-2018 | 5/5 (100%) |
| Mentoring (RCR-Refresher) (ID: 15667) | 22-Feb-2018 | 5/5 (100%) |

**For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.**

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# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 1 OF 2
## COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- Name: Corinne Audette (ID: 4761624)
- Institution Affiliation: University of Central Florida (ID: 405)
- Institution Email: Corinne.Audette@ucf.edu
- Institution Unit: Nursing
- Phone: 6155169248

- Curriculum Group: CITI Good Clinical Practice
- Course Learner Group: GCP for Clinical Trials with Investigational Drugs and Medical Devices (U.S. FDA Focus)
- Stage: Stage 1 - GCP
- Description: This course is for investigators and staff who conduct FDA regulated research or international research with investigational drugs and devices according to ICH Guidelines.

- Record ID: 15664678
- Completion Date: 22-Feb-2018
- Expiration Date: 21-Feb-2021
- Minimum Passing: 80
- Reported Score*: 98

| REQUIRED AND ELECTIVE MODULES ONLY | DATE COMPLETED | SCORE |
|---|---|---|
| The CITI Good Clinical Practice Course for Clinical Trials Involving Drugs and Devices (ID: 1350) | 22-Feb-2018 | 3/3 (100%) |
| Overview of New Drug Development (ID: 1351) | 22-Feb-2018 | 5/5 (100%) |
| Overview of ICH GCP (ID: 1352) | 22-Feb-2018 | 4/4 (100%) |
| ICH - Comparison Between ICH GCP E6 and U.S. FDA Regulations (ID: 1354) | 22-Feb-2018 | 5/5 (100%) |
| Conducting Investigator-Initiated Studies According to FDA Regulations and GCP (ID: 1355) | 22-Feb-2018 | 3/3 (100%) |
| Investigator Obligations in FDA-Regulated Research (ID: 1356) | 22-Feb-2018 | 5/5 (100%) |
| Managing Investigational Agents According to GCP Requirements (ID: 1357) | 22-Feb-2018 | 5/5 (100%) |
| Overview of U.S. FDA Regulations for Medical Devices (ID: 1358) | 22-Feb-2018 | 3/3 (100%) |
| Informed Consent in Clinical Trials of Drugs, Biologics, and Devices (ID: 1359) | 22-Feb-2018 | 4/4 (100%) |
| Detecting and Evaluating Adverse Events (ID: 1360) | 22-Feb-2018 | 4/4 (100%) |
| Reporting Serious Adverse Events (ID: 1361) | 22-Feb-2018 | 3/4 (75%) |
| Audits and Inspections of Clinical Trials (ID: 1363) | 22-Feb-2018 | 5/5 (100%) |
| Monitoring of Clinical Trials by Industry Sponsors (ID: 1362) | 22-Feb-2018 | 5/5 (100%) |
| Completing the CITI GCP Course (ID: 1364) | 22-Feb-2018 | No Quiz |

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

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# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 2 OF 2
## COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Corinne Audette (ID: 4761624)
- **Institution Affiliation:** University of Central Florida (ID: 405)
- **Institution Email:** Corinne.Audette@ucf.edu
- **Institution Unit:** Nursing
- **Phone:** 6155169248

- **Curriculum Group:** CITI Good Clinical Practice
- **Course Learner Group:** GCP for Clinical Trials with Investigational Drugs and Medical Devices (U.S. FDA Focus)
- **Stage:** Stage 1 - GCP
- **Description:** This GCP training contains all of the attested CITI Program modules from the **GCP for Clinical Trials with Investigational Drugs and Medical Devices (U.S. FDA Focus) Version 2**. This ICH E6 GCP Investigator Site Training meets the Minimum Criteria for ICH GCP Investigator Site Personnel Training identified by TransCelerate BioPharma as necessary to enable mutual recognition of GCP training among trial sponsors.

- **Record ID:** 15664678
- **Report Date:** 11-Oct-2019
- **Current Score**:** 98

| REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES | MOST RECENT | SCORE |
|---|---|---|
| The CITI Good Clinical Practice Course for Clinical Trials Involving Drugs and Devices (ID: 1350) | 22-Feb-2018 | 3/3 (100%) |
| Overview of New Drug Development (ID: 1351) | 22-Feb-2018 | 5/5 (100%) |
| Overview of ICH GCP (ID: 1352) | 22-Feb-2018 | 4/4 (100%) |
| ICH - Comparison Between ICH GCP E6 and U.S. FDA Regulations (ID: 1354) | 22-Feb-2018 | 5/5 (100%) |
| Conducting Investigator-Initiated Studies According to FDA Regulations and GCP (ID: 1355) | 22-Feb-2018 | 3/3 (100%) |
| Investigator Obligations in FDA-Regulated Research (ID: 1356) | 22-Feb-2018 | 5/5 (100%) |
| Managing Investigational Agents According to GCP Requirements (ID: 1357) | 22-Feb-2018 | 5/5 (100%) |
| Overview of U.S. FDA Regulations for Medical Devices (ID: 1358) | 22-Feb-2018 | 3/3 (100%) |
| Informed Consent in Clinical Trials of Drugs, Biologics, and Devices (ID: 1359) | 22-Feb-2018 | 4/4 (100%) |
| Detecting and Evaluating Adverse Events (ID: 1360) | 22-Feb-2018 | 4/4 (100%) |
| Reporting Serious Adverse Events (ID: 1361) | 22-Feb-2018 | 3/4 (75%) |
| Monitoring of Clinical Trials by Industry Sponsors (ID: 1362) | 22-Feb-2018 | 5/5 (100%) |
| Audits and Inspections of Clinical Trials (ID: 1363) | 22-Feb-2018 | 5/5 (100%) |
| Completing the CITI GCP Course (ID: 1364) | 22-Feb-2018 | No Quiz |

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7ed7e82-689b-419d-8a44-9c078e8bf029-15664678

# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 1 OF 2
## COURSEWORK REQUIREMENTS*

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- **Name:** Corinne Audette (ID: 4761624)
- **Institution Affiliation:** University of Central Florida (ID: 405)
- **Institution Email:** Corinne.Audette@ucf.edu
- **Institution Unit:** Nursing
- **Phone:** 6155169248

- **Curriculum Group:** Conflict of Interest
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Stage 1

- **Record ID:** 15664681
- **Completion Date:** 22-Feb-2018
- **Expiration Date:** 21-Feb-2022
- **Minimum Passing:** 80
- **Reported Score*:** 90

| REQUIRED AND ELECTIVE MODULES ONLY | DATE COMPLETED | SCORE |
|---|---|---|
| Financial Conflicts of Interest: Overview, Investigator Responsibilities, and COI Rules (COI-Basic) (ID: 15070) | 22-Feb-2018 | 4/5 (80%) |
| Institutional Responsibilities as They Affect Investigators (COI-Basic) (ID: 15072) | 22-Feb-2018 | 5/5 (100%) |

**For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.**

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# COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

## COMPLETION REPORT - PART 2 OF 2
## COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Corinne Audette (ID: 4761624)
- **Institution Affiliation:** University of Central Florida (ID: 405)
- **Institution Email:** Corinne.Audette@ucf.edu
- **Institution Unit:** Nursing
- **Phone:** 6155169248

- **Curriculum Group:** Conflict of Interest
- **Course Learner Group:** Same as Curriculum Group
- **Stage:** Stage 1 - Stage 1

- **Record ID:** 15664681
- **Report Date:** 11-Oct-2019
- **Current Score**:** 90

| REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES | MOST RECENT | SCORE |
|---|---|---|
| Financial Conflicts of Interest: Overview, Investigator Responsibilities, and COI Rules (COI-Basic) (ID: 15070) | 22-Feb-2018 | 4/5 (80%) |
| Institutional Responsibilities as They Affect Investigators (COI-Basic) (ID: 15072) | 22-Feb-2018 | 5/5 (100%) |

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# APPENDIX E:

# PERMISSION TO REPRINT ANDERSEN'S BEHAVIORAL MODEL OF HEALTHCARE SERVICES USE

RA

Ron Anderssen <randerse@ucla.edu>
Wed 9/11/2019 5:46 PM
CorinneAudette

Dear Corinne,

You have my permission to use a diagram of my behavioral model in your dissertation. I assume you will use appropriate citation of the source you will use. Best wishes for the successful completion of your work.

Ron Andersen

...

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| Number of figures/tables/illustrations | 1 |
| Figures/tables/illustrations used | Figure 1: Phase 5: A behavioral model of health services use including contextual and individual characteristics. |
| Author of this Wolters Kluwer article | No |
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# APPENDIX F:

# CURRICULUM VITAE

**CORINNE AUDETTE MSN, CNM**

**Jonas Nurse Leader Scholar**

## EDUCATION

| Year | Degree | Institution | Clinical Major | Role Preparation |
|---|---|---|---|---|
| | PhD Student | University of Central Florida | Nursing | Nursing |
| 2007 | MSN | University of Florida | Nursing | Nurse Midwifery |
| 2006 | BSN | Bethune Cookman University | Nursing | Nursing |

## LICENSURE/CERTIFICATION

| | |
|---|---|
| APRN | Florida, 9249911 |
| APN | Tennessee, 17215 |
| RN | Tennessee, 191266 |

## EMPLOYMENT

***ACADEMIC APPOINTMENTS*:**

| | |
|---|---|
| 08/16-05/18 | **Jonas Nurse Leader Scholar,** Jonas Center for Nursing and Veterans Healthcare, New York, NY |
| 08/15-07/16 | **Graduate Research Associate,** Florida Center for Nursing, Orlando, FL |
| 06/15-08/15 | **Graduate Teaching Assistant,** University of Central Florida College of Nursing, Orlando, FL |
| 08/14-05/15 | **Assistant Professor,** Remington College of Nursing, Heathrow, FL |
| 02/12-07/13 | **Assistant Professor**, Vanderbilt University College of Medicine, Nashville, TN |

***CLINICAL APPOINTMENTS:***

| | |
|---|---|
| 02/18-Present | **Medical Science Liaison,** Allergan Pharmaceuticals Women's Health, Orlando, FL |
| 11/14-02/2018 | **Nurse Midwife**, Women's and Maternity Care Specialist, Winter Park, FL |
| 2012-2018 | **Site Inspector,** American Congress of Obstetricians and Gynecologist, Washington DC |

| | |
|---|---|
| 07/14-2016 | **PRN Nurse Midwife,** Planned Parenthood of Greater Orlando, Orlando, FL |
| 07/13-07/14 | **Nurse Midwife**, Physician Associates, Winnie Palmer Hospital, Orlando, FL |
| 02/12-07/13 | **Nurse Midwife,** Associate Professor, Vanderbilt University, Nashville, TN |
| 11/10-01/12 | **Nurse Midwife**, Physician Associates, Winnie Palmer Hospital, Orlando, FL |
| 01/08-11/10 | **Nurse Midwife,** Lakeland Ob/Gyn at Central Florida Healthcare, Lakeland, FL |

## PUBLICATIONS

***REFEREED JOURNALS***:

**Audette, C.,** & Neff, D**.** (in review) INFLUENCE OF ACCESS TO PRENATAL CARE ON POOR BIRTH OUTCOMES: AN INTEGRATIVE REVIEW

**Audette, C.,** & Waterman, J. (2010). The Sexual Health of Women after Gynecologic Malignancy. *Journal of Midwifery and Women's Health, 55:4, 357-362.*

**Audette, C.,** & Waterman, J. (2010). Share with Women: Sexual Health and Dysfunction. *Journal of Midwifery and Women's Health, 55:4, 395-396.*

***NON-REFEREED JOURNALS OR PUBLICATIONS:***

**Audette, C.** (2018-in press). Uterine Fibroids: a benign condition with a significant burden for women.

**Audette**, **C**. (2013). Is CrossFit safe when you're pregnant? *According to Winnie*.

**Audette**, **C**. (2013). Is it possible to choose a vaginal birth after cesarean section? *According to Winnie*.

**Audette**, **C**. (2013). What is a Certified Nurse-Midwife (CNM)? *According to Winnie*.

## RESEARCH and GRANTS

| **Date** | Role | Title | Agency | Type | Amount |
|---|---|---|---|---|---|
| 08/16 | Scholar | Jonas V Nurse Leader Scholar | Jonas Center for Nursing and Veterans Healthcare | Fellowship | 20,000 |

## OTHER FUNDING

| **Date** | Role | Title | Agency | Type | Amount |
|---|---|---|---|---|---|
| 01/16 | Scholarship | Femmes de Couer Nursing Scholarship | University of Central Florida | Scholarship | 1,200 |
| 05/16 | Research | Graduate Nurse Scholar | March of Dimes National | Scholarship | 5,000 |

| | | | | | |
|---|---|---|---|---|---|
| 08/16 | Scholarship | Nurse Faculty Loan Program | HRSA | Scholarship | 1,300 |

**PRESENTATIONS—NATIONAL/INTERNATIONAL**

| **Date** | Type | Title/Authors | Conference Title, City/State | Refereed/ Invited |
|---|---|---|---|---|
| 06/11 | Podium | Sexual Health of Women after Gynecologic Malignancy<br>Audette, C. & Waterman, J. | American College of Nurse Midwives, Annual Conference, Washington, D.C. | Refereed |

**PRESENTATIONS—LOCAL/REGIONAL/STATE**

| **Date** | Type | Title/Authors | Conference Title, City/State | Refereed/ Invited |
|---|---|---|---|---|
| 2/16 | Poster | Nurse practitioner perceptions of their primary care organizational climate.<br>Neff, D.F., Ritten, A., & Audette, C. | Southern Nursing Research Society Annual Conference Williamsburg, Virginia | Refereed |
| 01/13 | Podium | The importance of assessing sexual health during well women exams.<br>Audette, C. | Grand Rounds Winnie Palmer Ob/Gyn Department, Orlando, FL | Refereed |

**HONORS/AWARDS**

| **Date** | **Award** | **Organization/Group** |
|---|---|---|
| 2008 | Mary Elizabeth Hillard Award for Excellence in Leadership and Scholarship in Nurse Midwifery | University of Florida, College of Nursing |

**PROFESSIONAL ACTIVITIES & COMMUNITY SERVICE**

***PROFESSIONAL ORGANIZATIONS:***

| Date | Organization | Role |
|---|---|---|
| 2015-2018 | Southern Nursing Research Society | Member |
| 2010-Present | American Congress of Obstetricians & Gynecology | Associate Member |
| 2008-Present | American College of Nurse Midwives | Member |

***PUBLICATION EDITORIAL BOARDS AND REVIEW:***

| Date | Journal or Publisher | Role |
|---|---|---|
| 2011-Present | *Journal of Midwifery and Women's Health* | Peer Reviewer |

***COMMUNITY SERVICE:***

| Date | Organization | Role |
|---|---|---|
| 2017-2018 | State of Florida Midwifery Regulatory Board | Governor Appointed Nurse Midwifery Board Member |
| 2015-2018 | Central Florida Birth Chamber of Commerce | Board Member |
| 2014-2018 | Florida Nurse Midwives Legislative Committee | State of Florida Representative |
| 2013-2016 | Central Florida Nurse Midwives Affiliate | Chapter Chair |
| 2010 - 2012 | Obstetrical Safety and Quality Review Board-Orlando Health at Winnie Palmer Hospital | Midwifery Representative |
| 2009-2012 | American College of Nurse Midwives Government Affairs Committee | Southeastern Regional Representative |
| 2008-2013 | A Woman's Choice | Volunteer |