

# Maternal Healthcare Access Disparities in North Carolina, 2016-2019: A Fine-Scale Geospatial Analysis

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## Introduction

- Access to maternal health providers is associated with lower rates of preterm births, cesareans, and pre-eclampsia.
- Socioeconomic and geographic disparities exist in who has access to maternal health providers.
  - Rural areas have longer drive time, more obstetric unit closures.
- Disparities in maternal & infant health outcomes also exist.
  - Black maternal individuals have higher rates of maternal mortality.

## Objective

**Purpose:** Investigate disparities in access to maternal healthcare (MH) providers in North Carolina at block group, and measure their associations with maternal and infant health outcomes at the individual level, from 2016 to 2019.

- Calculate accessibility at block group level to understand geographic variations in North Carolina.
- Identify association between access and health outcomes at individual level.
- Identify how individual and community covariates influence the relationship between access and health outcomes.
- Identify disparities.

## Methods

### Calculate MH Accessibility

- Geocode MH providers in ArcGIS Pro
- Population assigned centroids block group level.
- Travel time distances
- Implement generalized enhanced two-step catchment area (E2SCA) method

### Measure associations and identify disparities (Statistical Analysis)

- Set covariate reference levels
- Multilevel logistic regression models (glmmTMB package)
  - Adjusted models
  - Effect modification models
- Log likelihood ratio tests (model adequacy)

**E2SCA:** technique for **computing relative accessibility scores**. This method integrates a **distance decay** function and **supply-demand** to account for variations in accessibility to providers.

- Steps:
  - Calculate travel times** (< 60min) between providers and block group centroids, in ArcGIS Pro using OD Cost Matrix Tool.
  - In R – **Set distance decay, distance weights and capacity parameters:**
    - Provider Capacity = 1000 per provider
    - Distance decay: 15 min, 30 min, 60 min
    - 15 min = 1, 30 min = 0.67, 60 min = 0.33
  - In R – **Calculate access scores** using equations 1 & 2

$$R_j = \frac{s_j}{\sum_{i \in [d_j < d]} P_i W_{ij}}$$

$$A_i = \sum_{j \in [d_j < d]} R_j W_{ij}$$

## Data

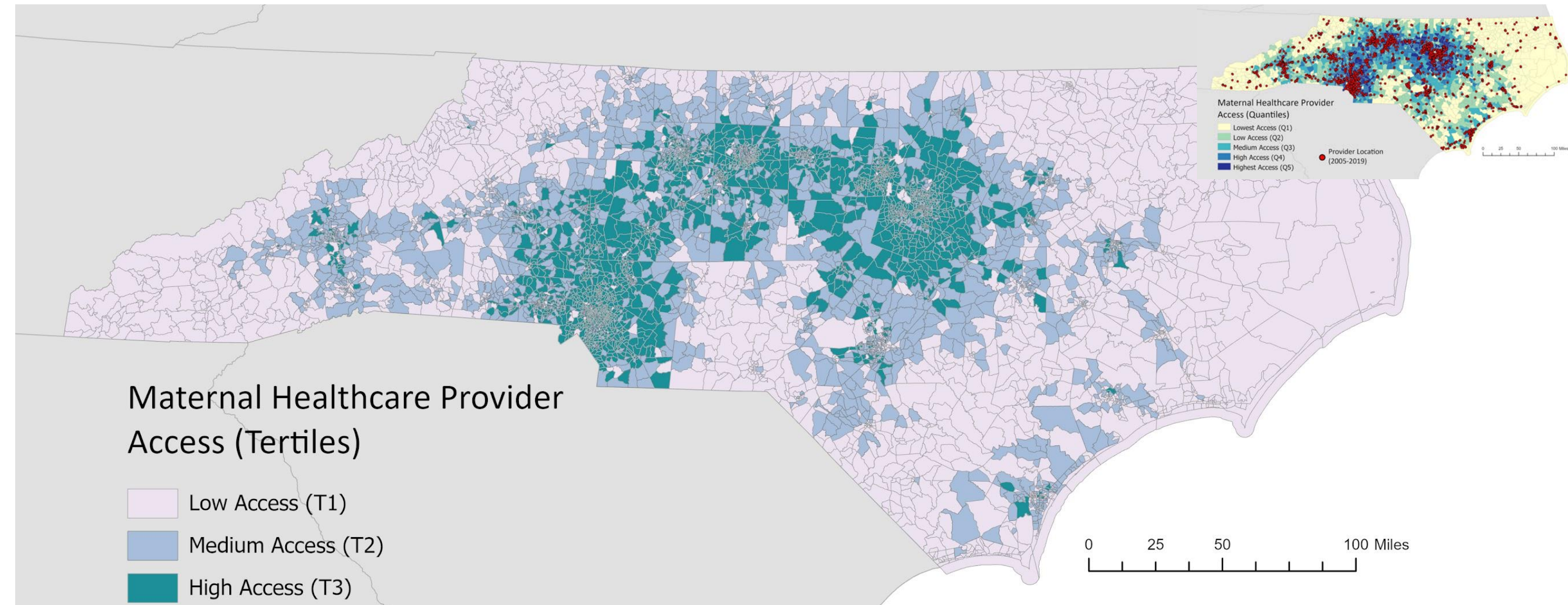
Type	Source	Timeframe, Extent	Variables
<b>Accessibility</b>			
<b>Provider Data</b>	Centers for Medicare and Medicaid Services' (CMS) National Plan and Provider Enumeration System (NPPES)	2005-2019; point-level	NPI, taxonomy code, addresses, start date
<b>Female Population</b>	American Community Survey (ACS), 5yr estimates	2015-2019; 2010 block group level	GEOID, Female pop. age 15-44
<b>Maternal &amp; Infant Outcome Data</b>			
<b>Maternal Health outcomes</b>	Vital Statistics Department of North Carolina State Center for Health Statistics; Children's Environmental Health Initiative (CEHI)	2016-2019; point-level	VISITS (# of prenatal care visits), PIH (pregnancy-induced hypertension), GDB (gestational diabetes)
<b>Infant Health outcomes</b>			LBW (low birth weight), PTB (pre-term birth),
<b>Covariates</b>			
<b>Maternal Individual level</b>	Vital Statistics Department of North Carolina State Center for Health Statistics; Children's Environmental Health Initiative (CEHI)	2016-2019; point-level	maternal individual's Age, Race, Education; MWIC (WIC food for maternal individual), PAY (Principal source of payment), APNC (adequate prenatal care index)
<b>Community level</b>	Children's Environmental Health Initiative (CEHI)	2015; 2010 block group-level	Area Deprivation Index (ADI) state ranks (0-10)

## Maternal Healthcare Providers

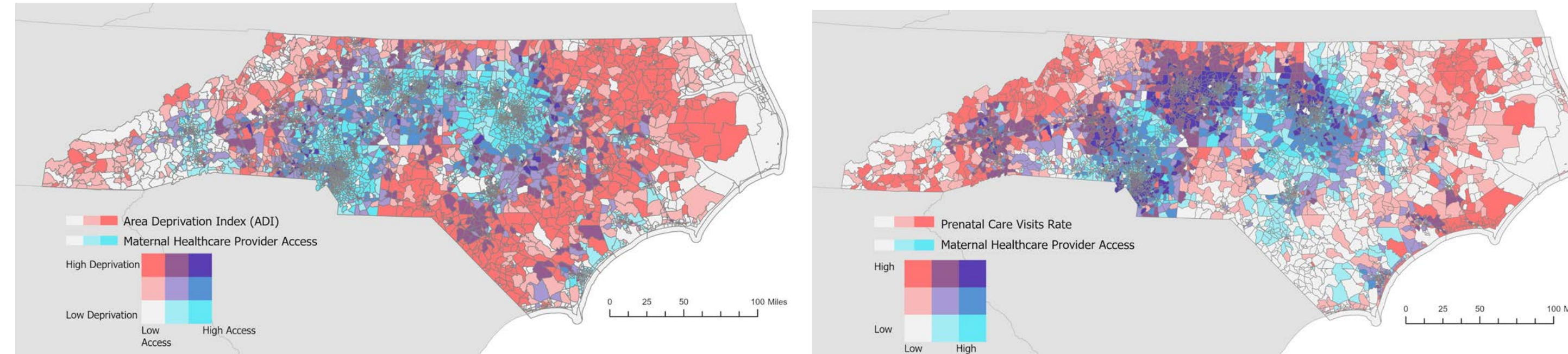
Provider Type	Taxonomy Code	Count
<b>Ob-gyns</b>	207V00000X, 207VG0400X, 207VM0101X, 207VX0000X	2,405
<b>Midwives</b>	175M00000X, 176B00000X	80
<b>Nurse Practitioner (ob-gyn)</b>	363LX0001X	94
<b>Family Physician</b>	207Q00000X	6895
<b>Registered Nurse</b>	[maternal newborn] 163WM0102X, [obstetric high-risk] 163WX0002X, [obstetric inpatient] 163WX0003X	36
<b>Pediatrics</b>	[Neonatal-perinatal medicine] 2080N0001X	237

**Table 2.** MH providers included in the study and the number of providers by type from 2005-2019 in North Carolina.

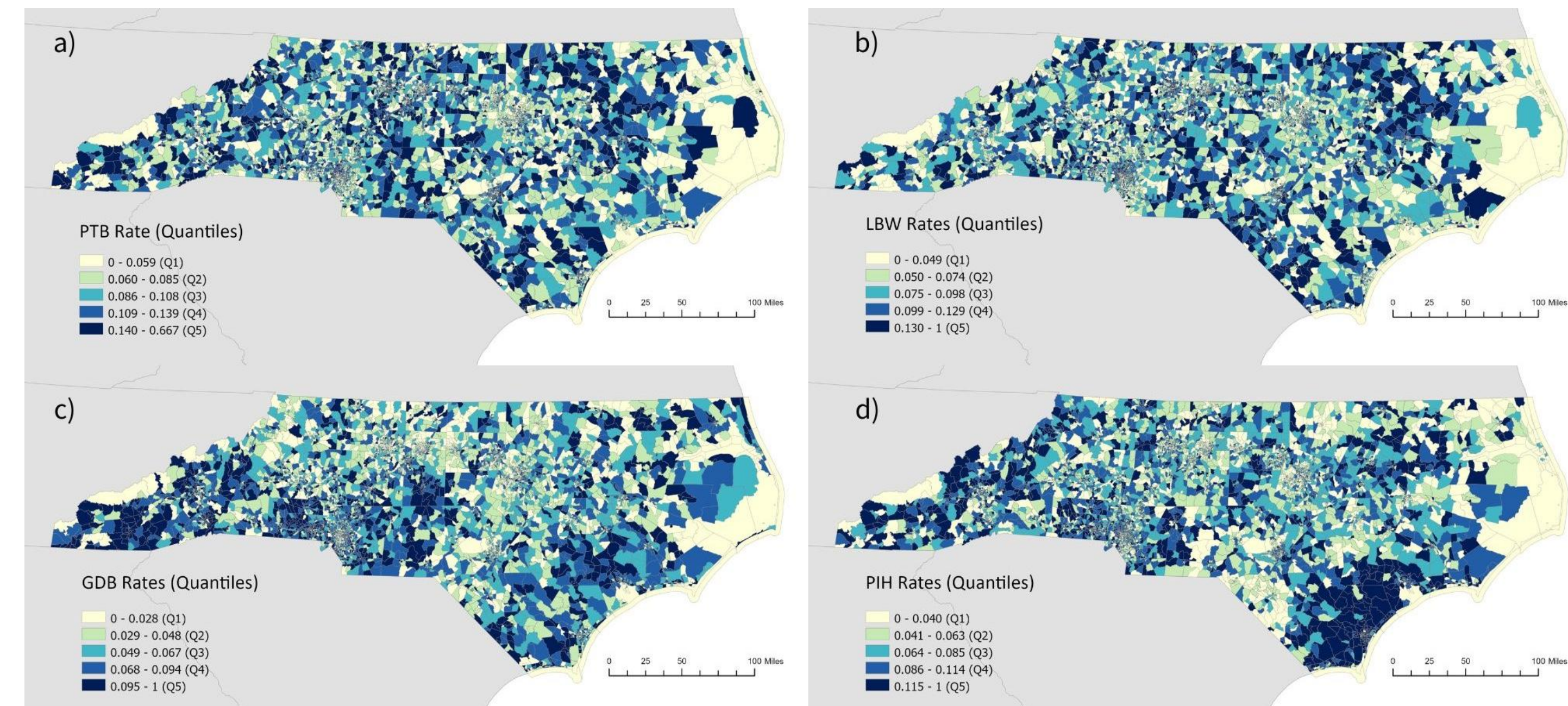
## Spatial Results



**Figure 1.** Spatial distribution of accessibility metrics scores for MH provider access for 2016-2019, NC, block group level. **Low-access areas are in Western and Northeastern NC.**



**Figure 2. Left:** Bivariate map of accessibility scores and ADI for 2016-2019, NC, block group level. **Right:** Bivariate map of accessibility scores and rates of prenatal visits for 2016-2019, NC, block group level. **Low-access areas are also areas with higher area deprivation (ADI).**

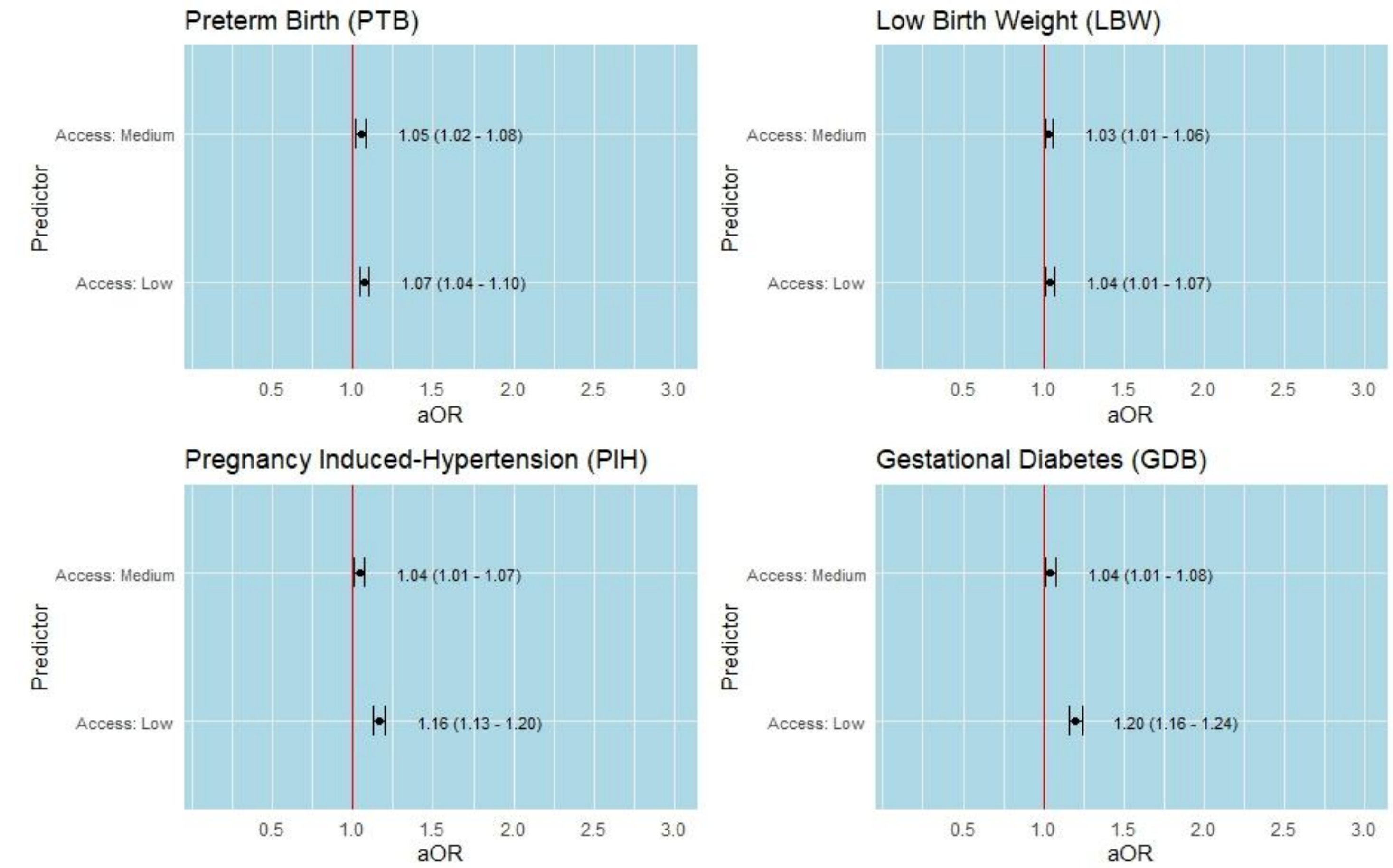


**Figure 3.** Spatial distribution of severe maternal and infant health outcomes for 2016-2019, NC, block group level. a) Preterm Birth (PTB), b) Low-Birth Weight (LBW), c) Gestational Diabetes (GDB), d) Pregnancy Induced-Hypertension (PIH). **Higher rates of GDB are predominantly in Southern NC, PIH in Southeastern NC, and PTB and LBW in Northeastern NC. Areas with higher rates of severe maternal and infant health outcomes are also areas with lower access to MH providers.**

Disclaimer: The findings and conclusions in this poster are those of the author(s) and do not necessarily represent the views of the North Carolina Department of Health and Human Services, Division of Public Health.

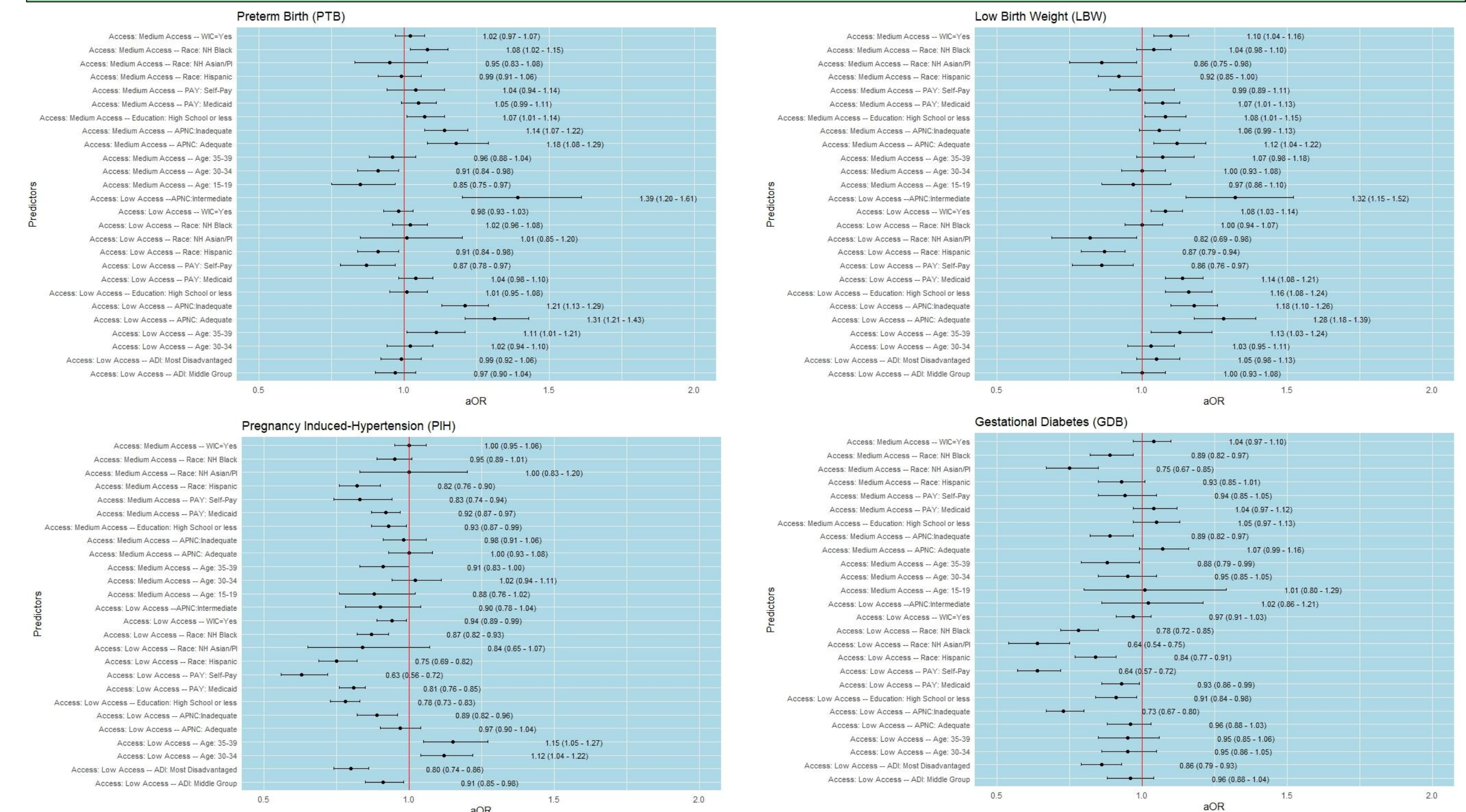
## Statistical Results

### Adjusted Models



**Figure 4.** Forest Plots of adjusted odds ratio (aOR) for severe maternal health outcomes (i.e. PTB, LBW, PIH, GDB) with respect to access adjusted for maternal individual's race, education, age, WIC, pay group, APNC.

### Effect Modification Models



**Figure 5.** Forest Plots of adjusted odds ratio (aOR) for severe maternal health outcomes (i.e. PTB, LBW, PIH, GDB) for effect modification models.

## Findings

- Geographic disparities exist** as low-access areas are predominantly in Western and Northeastern NC and low-access areas have higher odds of severe maternal & infant health outcomes.
- Effect modification analyses indicated that **insurance type, WIC participation, maternal age (30-39 years), and educational attainment (high school)** significantly influenced the relationship between accessibility and adverse outcomes, particularly PTB and LBW.
- Urgent need for more **MH providers to practice in low-access areas** like Western and Northeastern North Carolina.
- Further **analysis is needed to understand regional variations** of covariate drivers in access to care in North Carolina.