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Mapping maternity care deserts: Driving distance and health outcomes in North Carolina

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Abstract

Objective: This study evaluated the association between maternal care deserts (MCDs)—defined by accessibility measures such as travel time and distance to obstetric and gynecological care—and maternal and infant health outcomes in North Carolina from 2016 to 2021.

Methods: This was a retrospective secondary data analysis examining residents of North Carolina from 2016 to 2021, using travel metrics from residential zip codes to the nearest clinical providers. Maternal and infant health outcomes were assessed using data from the National Plan and Provider Enumeration System (NPPES) from the Centers for Medicare & Medicaid Services (CMS) and inpatient hospitalization records for North Carolina. Outcomes of interest included cesarean delivery rates, severe maternal morbidity (SMM20 and SMM21), and hypertension, which were examined across rural-urban disparities based on RUCA codes. Statistical analyses were conducted to link travel metrics with health outcomes, adjusting for age, race, and insurance status to control for potential confounding factors.

Results: The study found that rural and low-income areas in North Carolina had fewer health care providers. Increased travel times and distances to clinical care were associated with higher cesarean delivery rates, increased severe maternal morbidity, preterm birth, and higher rates of gestational diabetes. These associations remained significant even after adjusting for age, race, and insurance status.

Conclusion: Women living in maternal care deserts in North Carolina, often in rural locations, are more likely to experience adverse health outcomes, including severe maternal morbidity and hypertension, likely due to limited access to essential obstetric and gynecological care. These findings highlight the negative impact of health care inaccessibility on maternal and infant health in underserved regions.

KEYWORDS
access to care, geography, health disparities, Medicaid, utilization of health services

INTRODUCTION

Access to maternity care is decreasing in parts of the United States against the backdrop of increasing maternal deaths and adverse maternal health outcomes.[1] Between 2006 and 2020, more than 400 maternity services closed as the maternal mortality rate increased, particularly for Black women.[2] Workforce shortages and obstetric unit closures have given rise to the term "maternity care desert," describing geographic areas with limited maternal health services. According to the March of Dimes, areas of no or low care affect 2.3 million women and up to 150,000 births across the United States.[3] As maternal mortality rates continue to rise at an alarming rate,[4] understanding the areas most impacted by declining access to maternal care is an emerging research priority.

A maternity care desert (MCD) is classified by the March of Dimes as a county without any hospitals or birth centers offering obstetric (OB) care or zero OB providers per 10,000 births.[3] The majority of maternity care deserts are located within Midwestern and Southern states and disproportionately underserved populations, including rural communities, women of color, and underinsured women.[3] Women living in MCDs are at an increased risk of pregnancy-related death up to 1 year postpartum[5] and face barriers to standard health care.[6]

Maternity services are especially scarce in rural areas, with over 45% having no maternity services, increasing travel time and distance for rural women.[2] These increased travel times and distances for OB services, a proxy for MCDs, are associated with higher rates of newborn morbidity and mortality[7] and adverse perinatal outcomes.[5,8,9] Rural areas in the United States also have greater proportions of Medicaid recipients, a measure of low-income status.[2] One hundred rural hospitals closed from 2012 to 2022, with even more closures of OB units.[9,10] The discontinuation of delivery services at rural hospitals has been attributed to low birth volumes, low Medicaid payment, difficulty recruiting and retaining clinicians, and high liability insurance costs.[9] As a result, less than half of all rural counties have a hospital-based OB service.[6] Rural hospital closures are more likely to occur in the least populated areas, low-income communities, and areas with a limited supply of primary care physicians.[7,11,12]

Further research is needed to deepen the analysis of geographical factors influencing maternity care deserts (MCDs), as few studies have linked MCD metrics, such as travel time and distance, to maternal health outcomes. County-level categorizations of care deserts, like those developed by the March of Dimes, often overlook disparities in maternity care access that emerge at more localized scales and frequently exclude travel metrics.[13,14] Existing studies focus on county-level access, with only limited use of geographic information systems (GIS) to measure distances to care providers. Such studies include research conducted in Mozambique[15] and North Dakota, USA.[16] Additionally, despite the well-documented maternal health disparities in the United States, studies addressing the increasing prevalence of MCDs remain limited.[17] This study conducts a retrospective secondary data analysis to assess provider accessibility, measured as travel distance to obstetric clinicians, across North Carolina, a southeastern state facing significant maternal health disparities.[13,18] Key MCD metrics include geographic distance (in miles) and driving time (in minutes) from residential zip codes to the nearest obstetric care providers. This analysis also links MCD measures by including travel time, necessary in rural mountain areas like Western North Carolina, where short distances can take significant travel time. In addition, travel distance and time are key metrics for other studies examining health care deserts.[14,19] However, unlike prior work, we extend previous research by linking metrics to inpatient maternal (e.g., hypertensive disorders of pregnancy, gestational diabetes, cesarean delivery, severe maternal morbidity) and infant health data (e.g., preterm birth) to identify which outcomes are most sensitive to provider shortages. The results provide new evidence on how access to clinical providers influences maternal and infant health outcomes in North Carolina, USA.

DATA

We retrieved the National Plan and Provider Enumeration System (NPPES) public use file from 2016 to 2021 from the Centers for Medicare & Medicaid Services (CMS) national provider identifier (NPI) database. The NPI is a unique 10-digit identifier assigned to all health care providers eligible to bill insurers and covered under the Health Insurance Portability and Accountability Act.[20] It includes self-reported details on provider specialty, geographic practice location, and demographics and is required for any provider involved in clinical care who uses electronic health information transmission.[20] Based on the taxonomy codes, we identified actively practicing Obstetrics and Gynecology providers (OBGYNs; code: 207V00000X). Previous literature has used NPPES and taxonomy codes to identify Nurse Practitioners, Registered Nurses, Physician Assistants, and Pharmacists.[21–28] MCD was defined as a sub-county or Zip Code Tabulation Area (ZCTA) scale using OB/GYN provider locations. The ZCTA scale was selected as it is the smallest scale for inpatient health data, and the taxonomy represented the most likely to contain OB providers.

Inpatient hospitalization data for pregnant persons in North Carolina between 2016 and 2021 were included. Pregnancy-related visits were identified using the International Classification of Disease Codes version 10 for any diagnosis related to pregnancy (Z32, Z34, Z36) or pregnancy complications (O85–O92.79, O09–O16.9, O20–O29.93, O94, O98–O99, O9A–O9A.53). All postpartum encounters (ICD-CM-10: Z39) and pregnancy-related stillbirth (ICD-CM-10: Z37), abortion (ICD-CM-10: O03–O03.9, Z33.2, O04–O04.89, O07–O07.4), or abnormal ectopic pregnancy (O00–O02.9, O08–O08.9) were excluded. Inpatient hospitalization data include admission date, age, race and ethnicity, insurance status, and diagnostic codes. Specific conditions include (1) hypertensive disorders of pregnancy, (2) gestational diabetes, (3) preterm birth, (4) severe maternal morbidity, and (5) cesarean delivery and were identified using the International Classification of Diseases, Ninth Revision (ICD-9, before 2016) and Tenth Revision (ICD-10, after 2016) (Table S1). Because a unique ID for each pregnant person was not provided, multiple pregnancies from the same individual may have been counted more than once. Data were provided through a data-use agreement for NC Hospital Discharge Data from the University of North Carolina's Cecil G. Sheps Center for Health Services Research Center. This work was approved by the Appalachian State University's Institutional Review Board (HS-25-69)

Covariates

Individual-level determinants

Racial, ethnic, and socioeconomic disparities are well-recognized factors influencing maternal health outcomes in the United States.[13] To account for individual-level influences on these disparities, we included key demographic variables such as (1) Age (as a continuous variable), (2) Race and Ethnicity (categorical: White, American Indian, Asian, Black, Hispanic), and (3) Insurance status (categorical: commercial, government, other, or self-pay), serving as an indirect measure of socioeconomic status.

Index of concentration at the extremes

Community-level income and racial diversity were measured through spatial, social polarization and the Index Concentration at the Extremes. ICE was calculated for racial and economic segregation using 2021 American Community Survey data.[29,30] For ICE Income, comparisons are made between households earning ≤$25,000 and those with incomes ≥$125,000. For ICE Race, comparisons are made to Black or non-White Hispanic residents and groups that are White residents. The ICE scores were divided into tertiles to evaluate risk.

Rurality

Prior research has indicated that maternal health outcomes vary across these geographic categories, with rural areas often experiencing more significant health disparities.[13,14] To analyze geographic variation along the urban-rural spectrum, we utilized the USDA's Rural-Urban Commuting Area (RUCA) codes, which classify areas based on population density, urbanization, and commuting patterns. The ZCTAs were categorized as Urban (RUCA Codes 1–3), Micropolitan (RUCA Codes 4–6), Small Towns (RUCA Codes 7–9), or Rural/Isolated (RUCA Code 10), with Urban serving as the reference category for analysis.

COVID-19

Since our study period overlapped with the COVID-19 pandemic, we examined whether a delivery occurred before or after the onset of the pandemic. Specifically, deliveries before March 13, 2020, were classified as prepandemic, while those after March 13, 2020, were considered during-pandemic. The date of March 13, 2020, was chosen because it corresponds to the US President's national emergency declaration.[29]

METHODS

Provider addresses were geocoded to latitude and longitude geographic coordinates using ArcGIS Pro software (Esri, Redlands, California, USA).[31] We use the Open Source Routing Machine (OSRM) to determine the car driving distance (in miles) and duration and develop data for ZCTA-level access to OBGYNs, where we sum the inverse driving distance (in miles) and driving duration (in minutes) from population-weighted ZCTA to each OBGYN's practicing location.[32] We re-coded driving distances less than a mile as one mile and driving durations less than a minute as one minute to avoid skewing the data. Providers were then aggregated to the ZCTA Scale. Descriptive statistics include chi-square tests for categorical data and *t*-tests for continuous variables. Standardized mean differences were also calculated as a baseline comparison of group differences. In addition, accessibility measures were mapped spatially to depict MCDs and locations of lower accessibility within NC.

We employed generalized linear mixed models to assess the association between measures of MCDs and multiple health outcomes with relevant covariates. The outcomes analyzed included hypertensive disorders in pregnancy (HDP), gestational diabetes mellitus (GDM), preterm birth (PTB), severe maternal morbidity (SMM21, SMM20), and cesarean delivery. Each outcome was modeled using a binomial distribution with a logit link function. The primary covariates included age (continuous), race/ethnicity (categorical), MCD and accessibility (tertiles), insurance type (categorical), and the post-COVID period (binary). MCD and accessibility were categorized into tertiles to facilitate interpretation. Accessibility was measured as driving distance. We included a random intercept for residential ZCTA to account for geographic clustering. Random effects are crucial for quantifying variability across groups, and partial pooling improves stability in estimates for groups with limited data. All models were fitted using the *glmmTMB* package in R, which allows for complex random effects and unbalanced data.[33]

RESULTS

Table 1 provides the general sociodemographic and community characteristics across the three tertiles of accessibility (less, middle, most). The least accessible group is the youngest, with a higher proportion of White pregnant persons (57.2%) who predominately relied on Medicaid (51.9%). In addition, pregnant persons in the least accessible were more likely to reside in rural, small towns, or micropolitan locations that tend to be low-income (ICE Income Low: 48.2%). In contrast, the most accessible locations in NC had older pregnant persons, who were more likely to be racial and ethnic minorities (e.g., Black, Hispanic, and Asian). A larger portion relies on commercial insurance (56.1%) and live in more non-White neighborhoods (ICE Race Low: 48.8%) and higher-income neighborhoods (ICE Income High: 54.3%). Figure 1 presents a map of NC, illustrating the geographic distribution of different accessibility metrics, which highlights long travel times in the rural eastern and western portions of North Carolina.

TABLE 1 Demographic, clinical, and socioeconomic characteristics across three tercile levels of accessibility (less, middle, and most) with associated statistical significance (*p*-value) and standardized mean difference (SMD).

	Level	Less accessible	Middle accessible	Most accessible	*p*-value	SMD[1]
n		218,474	218,474	218,473		
Age (mean (SD))		27.53 (5.73)	28.42 (5.74)	29.74 (5.75)	<0.001	0.256
Rural-urban commuting code (%)	Urban	122,809 (56.2)	183,681 (84.1)	215,677 (98.7)	<0.001	0.798
	Micro	64,264 (29.4)	26,538 (12.1)	2652 (1.2)		
	Small town	18,532 (8.5)	7898 (3.6)	136 (0.1)		
	Rural	12,869 (5.9)	357 (0.2)	8 (0.0)		
Race and ethnicity (%)	White	124,914 (57.2)	121,640 (55.7)	84,681 (38.8)	<0.001	0.394
	Asian	1819 (0.8)	4505 (2.1)	13,888 (6.4)		
	Black	47,443 (21.7)	44,600 (20.4)	62,986 (28.8)		
	Hispanic	29,494 (13.5)	39,029 (17.9)	44,622 (20.4)		
	Indigenous American	7134 (3.3)	679 (0.3)	743 (0.3)		
	Other	7670 (3.5)	8021 (3.7)	11,553 (5.3)		
Insurance (%)	Commercial	85,919 (39.3)	107,981 (49.4)	122,584 (56.1)	<0.001	0.246
	Medicaid	113,344 (51.9)	96,019 (43.9)	82,138 (37.6)		
	Other	14,300 (6.5)	8917 (4.1)	6907 (3.2)		
	Self-pay	4911 (2.2)	5557 (2.5)	6844 (3.1)		
Post COVID (%)	Pre-COVID	170,876 (78.2)	169,275 (77.5)	147,439 (67.5)	<0.001	0.162
	Post-COVID	47,598 (21.8)	49,199 (22.5)	71,034 (32.5)		
Index Concentration at the Extremes—race (%)	High (predominately White communities, Value: 0.7223 to 1.00)	80,116 (36.7)	85,772 (39.3)	52,351 (24.0)	<0.001	0.409
	Medium (0.275 to 0.7222)	72,491 (33.2)	86,781 (39.7)	59,417 (27.2)		
	Low (predominately non-White communities, value: −1.00 to 0.274)	65,867 (30.1)	45,921 (21.0)	106,705 (48.8)		
Index Concentration at the Extremes—Income (%)	High (predominately high-income communities, value: 0.192 to 1.00)	23,021 (10.5)	77,279 (35.4)	118,612 (54.3)	<0.001	0.719
	Medium (value: 0.191 to 0.210)	90,217 (41.3)	66,937 (30.6)	61,414 (28.1)		
	Low (predominately low-income communities, value: −0.211 to 1.00)	105,236 (48.2)	74,258 (34.0)	38,447 (17.6)		

Note: Variables include age, race/ethnicity, insurance type, before/after COVID-19, and ICE (Index of Concentration at the Extremes) measures.
[1]SMD: standardized mean difference: a statistical measure used to quantify the difference between two group means, expressed in standard deviations.

MCD and underlying socioeconomic contexts

Figure 2 presents the results of regression models examining the association between geographic and socioeconomic factors and four health care access measures: Providers per 100,000 people, Inverse Distance, Inverse Driving Distance, and Inverse Duration. Higher estimates in the inverse variables indicate better access to health care (i.e., closer distances or shorter travel times). In contrast, negative estimates indicate poorer access (i.e., farther distances or longer travel times). Predominantly non-White communities (Low ICE Race) were significantly associated with better access to health care across all measures. Conversely, majority low-income communities (Low ICE Income) were significantly associated with poorer access to health care in all models, with estimates of −7.79 (95% CI: −8.61 to −6.97, $p < 0.001$) for Inverse Distance, −5.93 (95% CI: −6.58 to −5.27, $p < 0.001$) for Inverse Driving Distance, and −3.04 (95% CI: −3.38 to −2.70, $p < 0.001$) for Inverse Duration, indicating that individuals in this category needed to travel farther and for longer durations to access care.

As captured by rural-urban commuting codes (RUCA), geographic rurality was consistently associated with significantly reduced access. For example, rural areas had much lower estimates of −7.74 (95% CI: −8.61 to −6.86, $p < 0.001$) for Inverse Driving Distance and −4.65 (95% CI: −5.10 to −4.19, $p < 0.001$) for Inverse Duration, reflecting greater distances and longer travel times to health care providers. Small Town and Micro categories also had poorer access, though the effect was less pronounced. All additional analyses focused on inverse driving distance as measures were similar for association with health outcomes.

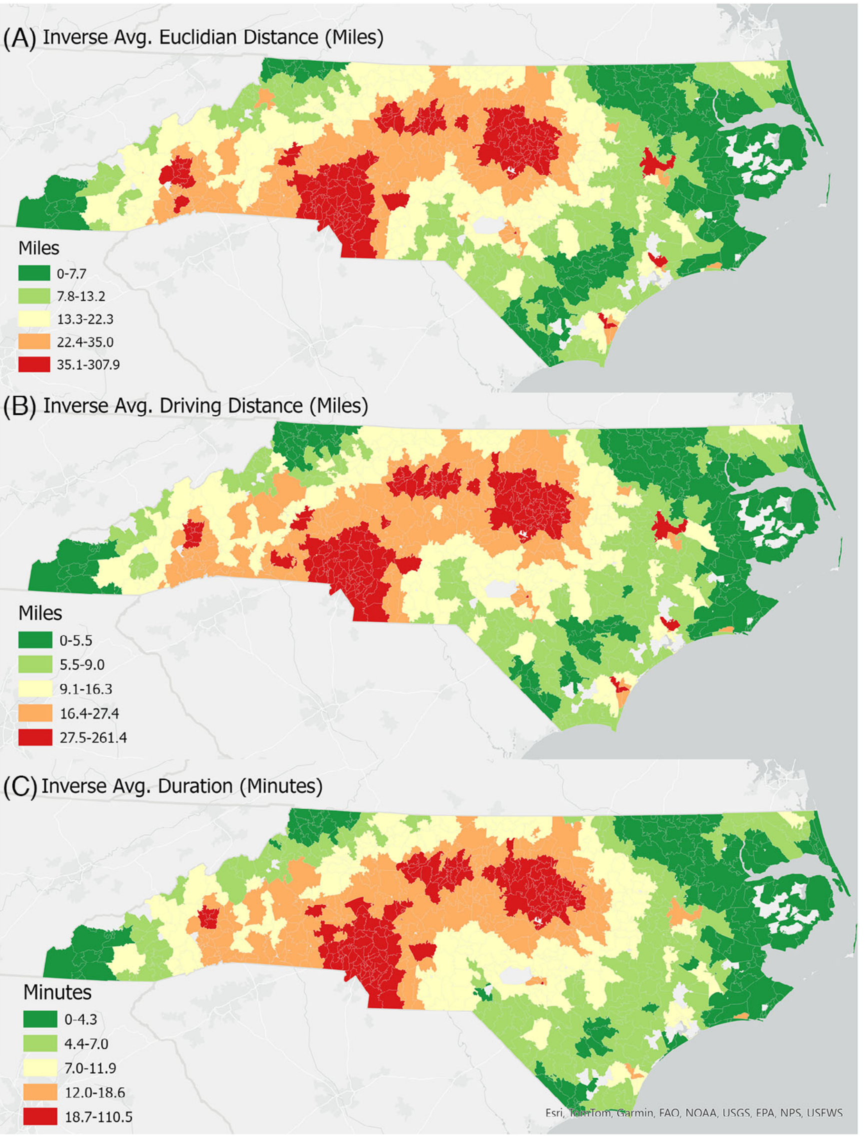

FIGURE 1 Geographic distribution of North Carolina divided into three panels, each illustrating different measures of health care accessibility using quantiles. Map 1 (top) shows the inverse average distance to health care providers. Map 2 (middle) displays the inverse driving distance to health care providers. Map 3 (bottom) presents the inverse travel time to health care providers, reflecting regions with quicker travel times.

MCD and health outcomes

Increased driving distance to health care services, a proxy of lower accessibility, was generally associated with poorer health outcomes (Figure 3). For instance, the lowest access groups (aOR: 1.15, 95% CI: 1.12 to 1.17) were significantly associated with greater gestational diabetes diagnoses than the most accessible areas. A similar association was found for preterm birth (aOR: 1.18, 95% CI: 1.15 to 1.20), hypertensive disorders of pregnancy (aOR: 1.03, 95% CI: 1.01 to 1.05), and cesarean delivery (aOR: 1.23, 95% CI: 1.20 to 1.26). In addition, the lowest accessibility was associated with higher odds of SMM20 (aOR: 1.09, 95% CI: 1.01 to 1.16) and SMM21, a similar metric that includes blood transfusion (aOR: 1.61, 95% CI: 1.54 to 1.69). Results were comparable across other distance metrics (e.g., travel time). Overall, Black women faced the highest risk of adverse maternal outcomes, and the COVID-19 pandemic further exacerbated maternal and infant health disparities (Figure 3, Table S3).

Effect modification

Effect modification was observed for minority race and ethnicity groups with a protective effect for most conditions, including hypertension, preterm birth, and gestational diabetes (Figure 4). However, Indigenous Americans with further distance to providers had significantly higher SMM20 (aOR: 2.31, 95% CI: 1.04 to 6.58), which contrasts with other racial-ethnic minorities like Black (aOR: 0.74, 95% CI: 0.63 to 0.86) and Hispanics (aOR: 0.8, 95% CI: 0.65 to 0.99). Medicaid, or low-income status, was a protective effect of hypertension, gestational diabetes, and preterm birth at a greater distance from the providers. However, cesarean deliveries increased for Medicaid patients with less accessibility or a higher driving distance (aOR: 1.14, 95% CI: 1.08 to 1.19). The COVID-19 pandemic had minimal impact on low access to maternal care, except for severe maternal morbidity, which showed a moderate yet significant protective effect during the pandemic period (aOR: 0.72–0.87, 95% CI: 0.65 to 1.01) (Table S4).

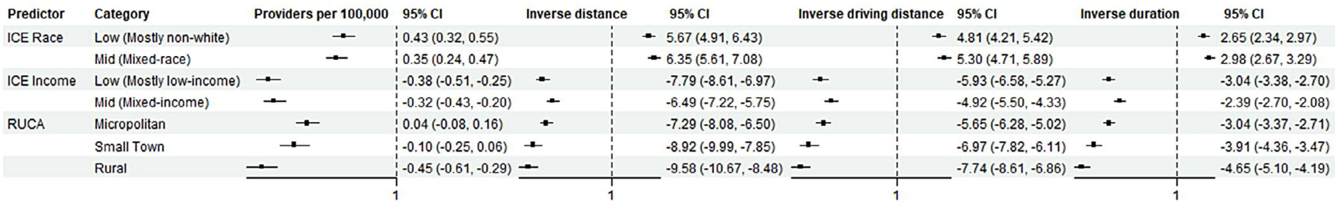

FIGURE 2 Forest plots depicting the association between geographic and socioeconomic factors and four health care access measures: Providers, Providers per 100,000 people, Inverse Distance, Inverse Driving Distance, and Inverse Duration. Higher estimates in the inverse variables indicate better access to health care (i.e., closer distances or shorter travel times). In contrast, negative estimates indicate poorer access (i.e., farther distances or longer travel times). Reference categories include *ICE Race*: high or the least segregated neighborhoods; *ICE Income*: high or the least economically segregated; and *RUCA*: rural (Rural and Isolated: RUCA 10). Values are odd ratios. *>The high-resolution version is attached via the online system portal.

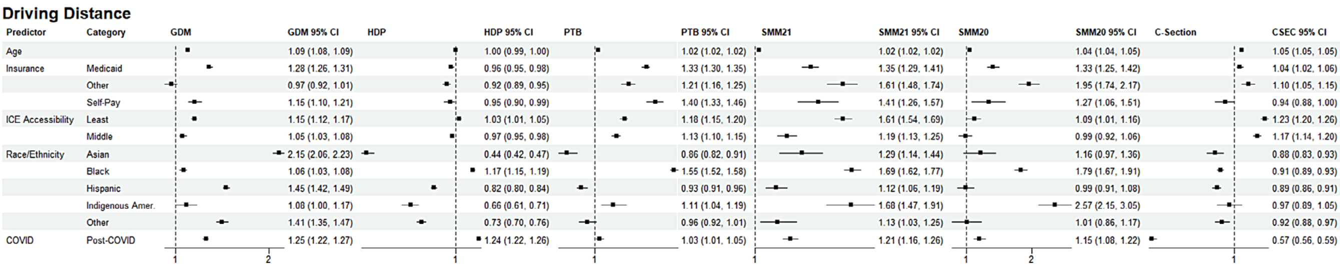

FIGURE 3 Forest plots depicting examining the association between health care access measures and socioeconomic factors for the following health outcomes: (1) GDM: gestational diabetes, (2) HDP: hypertensive disorders of pregnancy, (3) PTB: preterm birth, (4) SMM21: severe maternal morbidity with blood transfusion, (5) SMM20: severe maternal morbidity, (6) C-section: cesarean delivery. Reference categories include *Insurance*: commercial; *COVID-19*: pre-COVID-19 period; *ICE Race*: high or the least segregated neighborhoods; *ICE Income*: high or the least economically segregated; and *RUCA*: rural (Rural and Isolated: RUCA 10). Values are odd ratios. *The high-resolution version is attached via the online system portal.

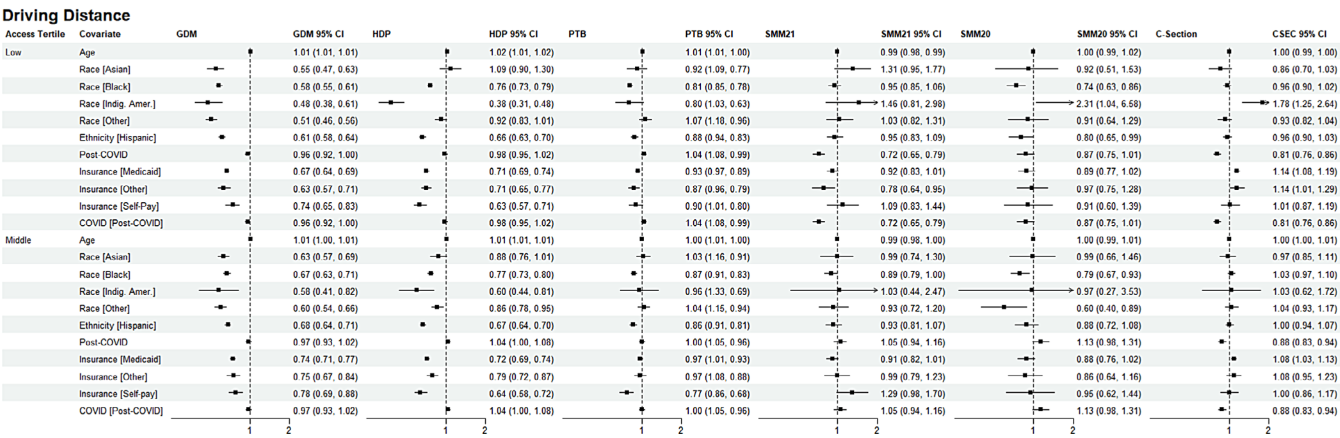

FIGURE 4 Forest plots depicting examining effect modification of health care access measures for the following health outcomes: (1) GDM: gestational diabetes, (2) HDP: hypertensive disorders of pregnancy, (3) PTB: preterm birth, (4) SMM21: severe maternal morbidity with blood transfusion, (5) SMM20: severe maternal morbidity, (6) C-section: cesarean delivery. Reference categories include *Insurance*: commercial; *COVID-19*: pre-COVID-19 period; *ICE Race*: high or the least segregated neighborhoods; *ICE Income*: high or the least economically segregated; and *RUCA*: rural (Rural and Isolated: RUCA 10). Values are odd ratios. *The high-resolution version is attached via the online system portal.

DISCUSSION

This study examines the association between accessibility measures as a proxy for MCD and maternal health and infant outcomes in North Carolina. We found an increase in severe maternal conditions, like SMM20 and SMM21, with increased driving distance after adjusting for important covariates like age, race, and insurance status. Other conditions, such as gestational diabetes, preterm birth, and cesarean delivery, also occurred at higher rates among women living in MCDs with long drive distances to clinical care. Our work provides additional context to past research showing lower accessibility is associated with maternal mortality and adverse neonatal outcomes.[5,8,34,35]

Additionally, we found that travel duration and length were highest in areas with predominately low-income populations and most rural locations of North Carolina. Nationally, roughly 20% of the US population lives in rural areas, but only 11% of physicians practice in these communities.[14] Instead, our study also noted that providers tend to practice in urban or more highly resourced areas.[36,37] Unlike previous studies, our research did not identify racial disparities in OB/GYN provider distribution;[5,7] rather, we found that low-income communities faced the greatest shortage of obstetric care. This pattern is consistent with broader health disparity trends in North Carolina, where socioeconomic factors appear to be stronger determinants of health outcomes than racial composition when analyzed through the Index of Concentration at the Extremes (ICE). Similar socioeconomic patterns have been documented as primary drivers of adolescent mental health outcomes[38] and maternal mental health burdens[39] in the state. These findings may reflect North Carolina's unique geographic and demographic landscape, particularly in regions such as the Appalachian Mountains of Western NC, which have comparatively low minority populations but experience disproportionately poor health outcomes, including maternal health metrics.[30,40,41] This demographic configuration may potentially mask underlying racial disparities in healthcare access, as socioeconomic status emerges as the predominant factor associated with OB/GYN provider shortages at the state level. More granular geospatial analyses are needed to fully elucidate the complex interplay between local healthcare access disparities and the community-level determinants influencing maternal and birth outcomes.

Our findings on SMM20 and SMM21 corroborate prior work that demonstrates rural residents have a higher rate of severe maternal mortality and morbidity (SMM) compared to urban residents.[42] These challenges are significantly heightened for socioeconomically vulnerable women,[8] who may struggle to cover the costs associated with driving long distances, including time off work, child care, transportation, etc.[43] Our work also corroborates national findings that hospitals with OB/GYN providers have a lower SMM rate;[34] we also find that fewer OB/GYN providers increase SMM occurrence, even after adjusting for covariates such as race, ethnicity, income, and age. As SMM represents a “near-miss” mortality event for pregnant persons,[44] our findings shed light on the consequences of limited maternal health care access for severe maternal complications.

We found that cesarean delivery rates increased with greater distance from clinicians. Nationally, rural cesarean delivery rates are more variable than their urban counterparts.[45] However, localized locations in the United States have found that pregnant women and their clinicians may schedule cesarean deliveries when the distance is too far to travel during labor.[11,46]

Lastly, our work supports increasing analysis showing higher rates of hypertensive disorders of pregnancy[47] and gestational diabetes.[48] Most troubling, hypertensive disorders account for 6.5% of pregnancy-related deaths.[49] We found increases in these maternal conditions in areas with fewer providers and locations that tend to be more rural. Our analysis shows that access to care is limited in these locations, and women in rural communities experience an already higher burden of adverse social determinants of health, influencing their underlying maternal health during pregnancy.[50]

Although maternal health conditions worsened during the pandemic (Figure 3), access to care did not significantly influence maternal and infant outcomes in the early stages of COVID-19 (Figure 4). A notable exception was severe maternal morbidity, which experienced a moderately significant decline in low-access areas during the pandemic. Further research is needed to explore the underlying mechanisms behind this protective effect, determine whether it persisted beyond the initial phase, and assess whether factors such as increased telehealth availability,[51] or staying at home during pregnancy contributed to improved maternal and infant health outcomes.

The study demonstrates the need for targeted interventions to improve maternal health care access in underserved areas. Potential interventions include expanding telehealth services for prenatal care, increasing affordable transportation options, and enhancing the availability of community health centers as alternative care points. Additionally, workforce incentives, such as loan forgiveness programs or competitive salaries, could encourage OB/GYN providers to practice in rural and low-income communities. Establishing standardized benchmarks for obstetric care access is also essential. While the American College of Obstetricians and Gynecologists recommends a 30-minute decision-to-incision time within hospitals,[52] there are no comparable national standards for timely obstetric care, unlike those for other medical emergencies such as stroke.[53] Future policies should focus on setting clear, evidence-based guidelines and ensuring equitable access to maternal health care across all communities.

Strength and limitations

This study has several notable strengths. First, our work includes geocoded coordinates of OB/GYN providers rather than OB hospitals, providing a more detailed estimate of clinical care available at a small geographic scale. In addition, rather than providing a total count of providers at a county level, a measure often used to define maternal health care deserts,[13,14] we include travel time and distance to ensure we capture local heterogeneity in access and a more precise measure of MCDs. Lastly, we extend prior work by including multiple maternal and infant outcomes, highlighting which outcomes are most sensitive to health care access. We extend earlier work in the United States by examining trends across an entire state[54] rather than a local hospital or city.[55]

Our work had several notable limitations. One key limitation is that we did not include alternative maternal health care providers, such as midwives or family physicians, who play a critical role in rural areas. Providers, such as family physicians, deliver around 10% of babies in such settings,[56,57] and their exclusion may have overlooked a significant aspect of maternal care access. Future research should incorporate these practitioners to more accurately capture the full scope of maternal health care accessibility and its impact on maternal and infant outcomes.[56,57] In addition, our analysis used the NPI database, which has been used in prior geographic analyses for access to the co-location of providers,[58] primary care providers,[59] and endocrinologists.[60] NPI database has several notable limitations, including relying on self-reported data, and providers may retire and/or move without updates. Despite these notable limitations, the NPI provides one of the only databases of geographic information (e.g., address) for clinical care providers. To enhance future analysis, mandatory updates of NPI among providers could increase data reliability, and including other datasets, such as Medicaid claims data (often cost-prohibitive for most research teams), could improve the accuracy of NPI geographic locations.

CONCLUSION

Our study highlights the significant impact of maternal care deserts (MCDs) and health care accessibility on maternal and infant outcomes in North Carolina using driving distance of obstetrics providers. We found that increased driving distance to clinical care was associated with higher rates of severe maternal conditions such as SMM20 and SMM21, as well as conditions like preterm birth, gestational diabetes and cesarean delivery. In general, rural and low-income locations in North Carolina had longer travel times, travel distances, and fewer providers for maternal health care. Future research and policy initiatives should prioritize mitigating these disparities through targeted interventions, ensuring that all women, regardless of geography, have timely access to comprehensive maternal health care.

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CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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