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Spatial access to hospital-based obstetric units in minoritized racial/ethnic areas

- Minoritized Areas: ZIP Code Tabulation Areas (ZCTAs) were classified as being a top minoritized place if the proportion of persons in the ZCTA who identified as a specific minoritized racial/ethnic group (MRG) met or exceeded the 95th percentile for the proportion of those residents in all rural or all urban ZCTAs respectively. Top MRG ZCTAs are not necessarily “majority” non-white places but rather fall at the top of the distribution for the proportion of the population represented by that group.
- Hospital-based obstetric services and MRG ZCTAs:
 - The average distance to reach a hospital obstetric unit in rural ZCTAs ranged from 17.9 miles in communities in the top Asian category to 31.1 miles top American Indian/Alaska Native (AI/AN) places. About 25% of top AI/AN ZCTAs are more than 64 miles from the nearest hospital with obstetric services.
 - Rural ZCTAs in the top Non-Hispanic Black category were least likely to be more than 30 miles from the nearest hospital with obstetric services (23.8%), while the proportion of ZCTAs with this level of travel burden was highest for top AI/AN ZCTAs (51.6%).
- Hospital-based obstetric services and rural ZCTAs in general:
 - Across all rural ZCTAs, 27.2% are more than 30 miles from a hospital-based obstetric services versus 8.9% among urban ZCTAs.
 - Median distance to a hospital with obstetric services was 20.0 miles for all rural ZCTAs versus 8.2 miles across all urban ZCTAs.

The current findings brief is one of a series of reports documenting disparities in geographic access to health services for places that have a relatively high proportion of residents from minoritized racial and ethnic groups (MRG). We use the term “minoritized” to refer to groups that have historically been marginalized by society and government institutions. This wording, rather than the terms “minority” or “minorities”, highlights the intentional social, economic, and political discrimination that these populations have experienced.¹ Work from this series has also been adapted into a web visualization² and a peer reviewed publication³ both in *Health Affairs*.

INTRODUCTION

Racial and ethnic disparities in maternal and infant health outcomes are well studied.¹⁻³ While 40% of US live births were to women of color from 1993-2016, nearly 66% of pregnancy-related deaths were experienced by women of color.^{4,5} Black and American Indian/Alaska Native (AI/AN) women are 2 to 3 times more likely to experience maternal morbidity and mortality than their non-Hispanic White counterparts regardless of the socioeconomic status.^{2,6,7} These disparities in maternal morbidity have persisted for over a decade.²

For women in rural communities, the differences between non-Hispanic White and Black or AI/AN women are even larger.^{3,7} While rural non-Hispanic White women had 1.1 times higher maternal morbidity and mortality rates than urban White women, rural Black women had 3 times higher rates, and rural AI/AN women had 2 times higher rates than urban White women.^{7,8} Disparities in maternal and infant health might result from higher proportions of minoritized populations living in “maternity care deserts,” as the numbers of maternity care providers and hospital-based obstetric units have been decreasing substantially during the past few decades.^{9,10}

Between 2004-2018, over 232 rural US counties experienced the loss of hospital-based obstetric units, raising concerns about lack of access to appropriate maternity care and associated detrimental outcomes.¹¹⁻¹³ Prior studies found an association between the loss of hospital obstetric units and increased emergency room births, preterm births,⁹ travel burdens for perinatal care,^{14,15} and maternal and neonatal mortality.¹⁶ As of 2018, over 56 percent of rural counties and nearly 40 percent of urban counties lacked a hospital-based obstetric unit,¹³ with rural isolated areas as well as non-White and low-income communities being disproportionately affected.^{10, 13} The maldistribution of hospital obstetric supply by geography, especially between rural and urban communities, has been well documented, but little is known regarding the geographic distributions of hospital obstetric units across communities of different racial/ethnic compositions.

To address racial/ethnic disparities in maternal and infant health outcomes, the US Surgeon General outlined a plan in 2020 to ensure maternal care workforce development, improve hospital quality of obstetric care, and address health disparities facing women of color.¹⁷ The Action Plan called for data in clinical practice patterns and access to care across minoritized women to improve surveillance and research.¹⁷ Commitment to reducing disparities for women of color and their newborns requires detailed information on the access to obstetric care in hospital settings, where nearly 99 percent of childbirths occur.¹⁸

The analyses presented here document spatial accessibility and travel burdens for obstetric care based on local racial/ethnic distributions at the ZIP Code Tabulation Area (ZCTA) level. ZCTAs are used, rather than larger geographic areas such as counties, to allow identification of small areas for calculation of approximate distances to obstetric care.

METHODS

Defining ZCTAs with a high proportion of minoritized racial/ethnic group residents

ZCTAs (n = 32,670) were first classified as rural or urban using Rural Urban Commuting Area definitions. ZCTAs classified as 1 through 3 are defined as urban, and those classified as 4 through 10 are classified as rural.¹⁹ Given differences in the demographic profile of rural and urban places, rural and urban ZCTAs were examined separately.

ZCTAs were classified as being a “top” MRG place if the proportion of persons who identified as a specific MRG group in the ZCTA met or exceeded the 95th percentile for the proportion of those residents in all rural or all urban ZCTAs respectively. The “top 5%” for any one population group was consistently less than a majority and for some populations was fairly low (Table 1, at right). “Hispanic” included all persons of Hispanic ethnicity,

regardless of race. ZCTAs that fell in the top category for more than one MRG population were grouped separately so that categories do not overlap. Thus, the final analysis included seven separate categories within both rural and urban ZCTAs: top ZCTAs for Black, Asian, American Indian/Alaska Native, Hispanic, and multiple MRG populations, non-Hispanic white, and a referent category which included all other ZCTAs (see Table 2 and Figure 1).

Table 1. Proportion of residents needed to meet or exceed the 95 percentile^a by race/ethnicity and rurality

| | Rural | Urban |
|--|--------|--------|
| Non-Hispanic Black | 34.4% | 49.3% |
| Hispanic | 23.8% | 34.1% |
| Non-Hispanic American Indian/Alaska Native | 11.8% | 2.2% |
| Non-Hispanic Asian | 2.5% | 15.3% |
| Non-Hispanic White | 100.0% | 100.0% |

^a Percentiles derived from population data obtained from the American Community Survey.

Table 2. Distribution of ZCTAs in the top 5th percentile for minoritized racial/ethnic group population by rurality and racial/ethnic group (2015-2019 American Community Survey)

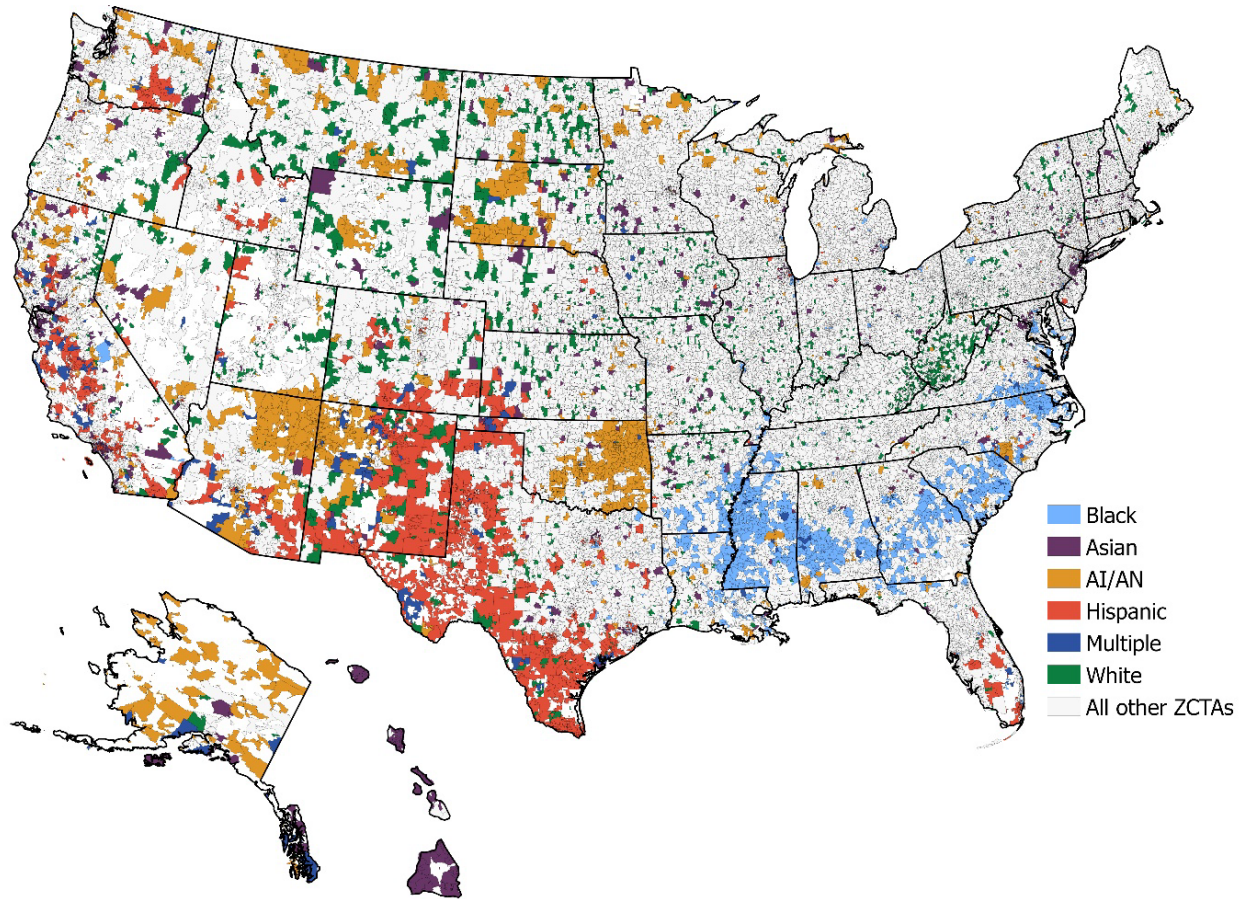
| Minoritized racial/ethnic group: | Urban ZCTAs | | Rural ZCTAs | | Total, all ZCTAs | |
|----------------------------------|-------------|-------|-------------|-------|------------------|-------|
| | n | % | n | % | n | % |
| Hispanic* | 755 | 4.2 | 594 | 4.0 | 1,349 | 4.1 |
| NH American Indian/Alaska Native | 825 | 4.6 | 668 | 4.5 | 1,493 | 4.6 |
| NH Asian | 851 | 4.8 | 622 | 4.2 | 1,473 | 4.5 |
| NH Black | 874 | 4.9 | 709 | 4.8 | 1,583 | 4.9 |
| > 1 MRG | 127 | 0.7 | 156 | 1.1 | 283 | 0.9 |
| NH White** | 1,203 | 6.8 | 2,177 | 14.6 | 3,380 | 10.4 |
| All other ZCTAs | 13,160 | 73.6 | 9,949 | 66.9 | 26,489 | 81.1 |
| Total | 17,795 | 100.0 | 14,875 | 100.0 | 32,670 | 100.0 |

Note: Percentiles derived from population data obtained from the 2015-2019 American Community Survey. More than 5% of ZCTAs in both urban and rural area had 100% white populations; all such ZCTAs were classified as high NH white ZCTAs.

*Hispanic includes all racial identities. All other racial/ethnic groups classified as “Non-Hispanic” (NH).

** The 90th percentile for the proportion of ZCTA residents who identified as NH White was 100%. The inclusion of all 100% NH White ZCTAs brings the total for this group over 5%.

Figure 1. Geographic distribution of ZCTAs meeting the 95th percentile threshold, by racial and ethnic group ^{a,b}



^aData from the 2015-2019 American Community Survey ^bThis map was adapted from Eberth et al,2022.

Note that MRG ZCTAs are not “majority minoritized” places; rather, they are ZCTAs in which the proportion of each group is at the top of the distribution compared to other ZCTAs. The geographic location of MRG ZCTAs is shown in Figure 1, above. Demographic characteristics of rural and urban ZCTAs, by top racial/ethnic group status, are presented in the Appendix.

How we measured “spatial availability” of hospital-based obstetric services

“Spatial availability” was defined as the one-way road distance, in miles, from each residential ZCTA centroid to the nearest hospital-based obstetric unit’s location per hospital longitude and latitude as derived from its address. Using the MapQuest application, we estimated driving distances using the fastest road distance per the maximum official driving speed limits. We also calculated the proportions of top MRG areas within specific distances (≤ 15 , 16-30, and > 30 miles) of the nearest obstetric services. Details are provided in the Appendix.

FINDINGS

Access to Hospital-Based Obstetric Units

In 2019, there were 2,770 hospitals with obstetric units; 1,084 (39.1%) in rural and 1,686 (60.9%) in urban ZCTAs. The map presented in Figure 2, below, overlays the locations of hospital-based obstetric units on the earlier map depicting top MRG ZCTAs. Hospital-based obstetric units are more clustered in urban ZCTAs.

Figure 2. Geocoded locations of hospital-based obstetric units across top MRG ZCTAs, 2019

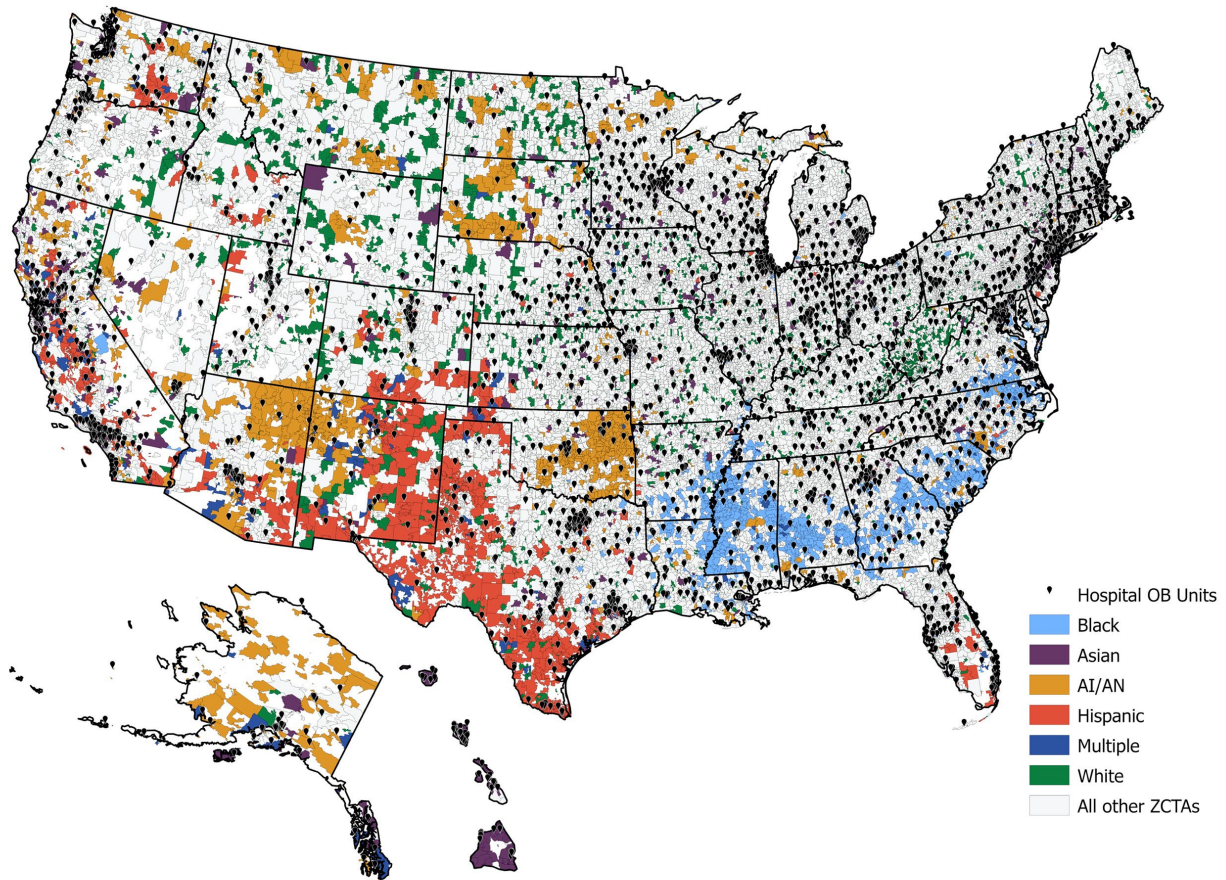


Figure 3 (next page) illustrates how far residents of each ZCTA have to travel to reach the nearest hospital with obstetric services. Colors are used to denote distance. Lighter shades indicate shorter trips (≤ 15 miles), and darker colors mark a distance of over 30 miles, the top of the scale. While some top MRG areas are adjacent to areas with better access, there is a large swathe of the US in which the travel burden for obstetric care is uniformly over 30 miles regardless of MRG status.

Figure 3. Geographic distributions of driving distances to a hospital obstetric unit by minoritized racial/ethnic group (MRG) classification

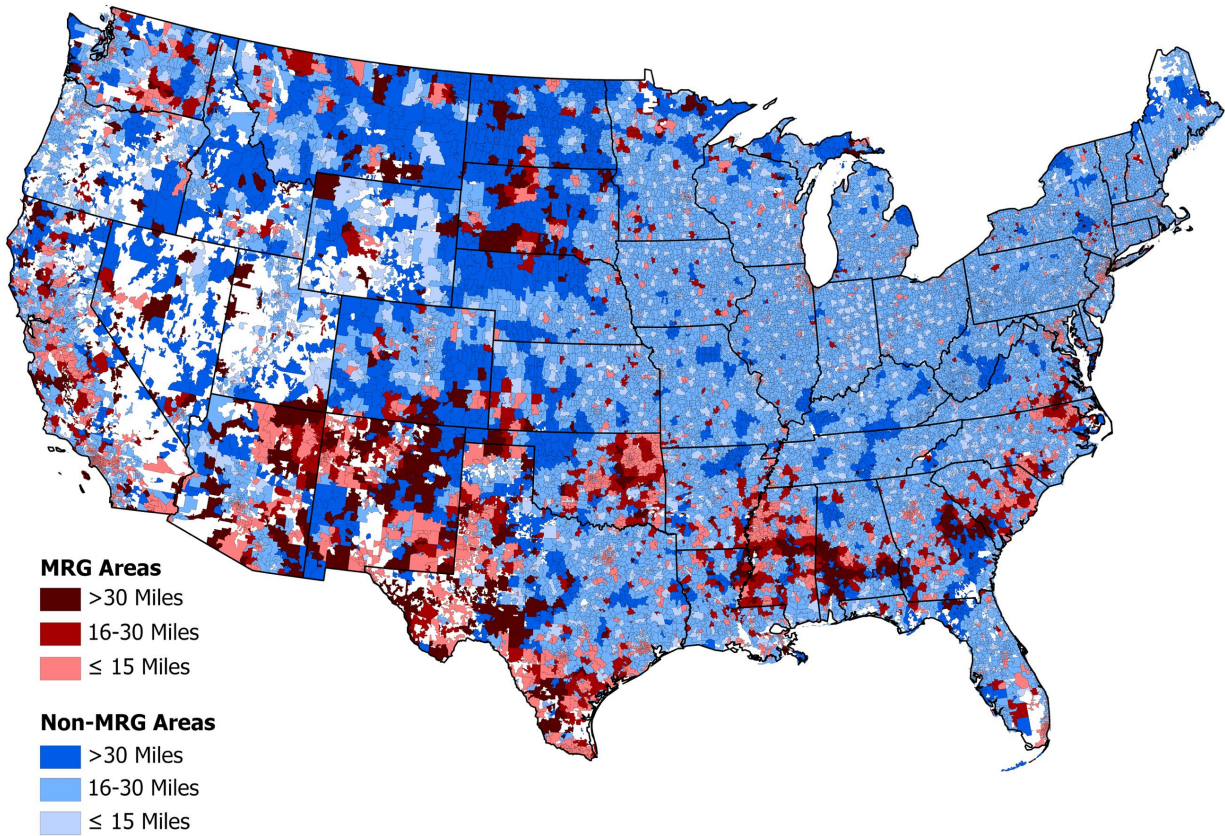


Table 3 (next page) shows the median distance, in miles, that residents in urban and rural ZCTAs have to drive to reach the nearest hospital-based obstetric unit, overall and by MRG classification. Table 3 also reflects the proportions of ZCTAs lacking a hospital obstetric unit within 15 and 30 road miles. Variations in driving miles to the nearest hospital obstetric unit are substantial between rural and urban ZCTAs and across different racial/ethnic groups. On average, compared to urban ZCTAs with the same highly represented racial/ethnic groups, MRG rural areas have 3 to 8-fold greater median distances to travel. Rural ZCTAs at the 95th percentile for the proportion of residents who identify as non-Hispanic White or those without highly represented MRG residents had moderately increased distances.

Across rural ZCTAs by race/ethnicity group, median distances to the nearest hospital obstetric unit range from 17.9 to 31.1 miles. Rural ZCTAs at the 95th percentile for the proportion of the population that identify as AI/AN have particularly limited access to hospital obstetric units. Specifically, over half of ZCTAs with a high representation of AI/AN residents are outside of a 30-mile drive to a hospital-based obstetric unit; in over a quarter of these ZCTAs, residents have to travel more than 60 miles [median: 31.1, interquartile: (17.0, 64.0)].

Table 3. Driving distances to the nearest hospital obstetric unit by rurality and top minoritized racial/ethnic group (MRG) status

| | Rural | | | Urban | | |
|-----------------------------------|--|--------------------------|----------|--------------------|--------------------------|-------|
| | Driving distances to nearest hospital-based obstetric unit | | | | | |
| | Median (IQR) miles | % with no access within: | | Median (IQR) miles | % with no access within: | |
| 15 miles | | 30 miles | 15 miles | | 30 miles | |
| All | 20.0 (12.1, 31.6) | 66.1% | 27.2% | 8.2 (3.5, 16.1) | 28.2% | 8.9% |
| NH Black | 19.8 (11.6, 29.0) | 67.0% | 23.8% | 3.8 (1.9, 8.8) | 15.8% | 2.4% |
| Hispanic | 22.3 (12.3, 35.4) | 67.1% | 33.4% | 3.6 (1.7, 7.3) | 8.1% | 2.0% |
| NH American Indian/ Alaska Native | 31.1 (17.0, 64.0) | 80.2% | 51.6% | 10.8 (4.5, 18.3) | 34.1% | 8.0% |
| NH Asian/Pacific Islander | 17.9 (8.9, 30.5) | 57.2% | 25.6% | 2.6 (1.4, 4.4) | 3.2% | 2.7% |
| Multiple Groups | 21.7 (11.2, 50.8) | 66.0% | 37.8% | 2.8 (1.6, 8.0) | 11.0% | 4.7% |
| NH White | 22.4 (14.5, 36.1) | 72.8% | 33.8% | 13.5 (8.4, 19.5) | 42.8% | 6.3% |
| All other ZCTAs ^c | 19.2 (11.7, 29.5) | 64.4% | 24.3% | 8.9 (4.0, 16.8) | 29.8% | 10.1% |

Note: IQR- interquartile range. Distance was measured from each ZCTA’s geographic centroid to the address of the closest hospital-based obstetric units using shortest-route distance approach calculated by Microsoft MapPoint 2013. ZCTAs with a “highly represented group” was defined as areas that met the 95th percentile criteria for a racial/ethnic group (refer to Table 1).

^c All other ZCTAs include those ZCTAs that did not meet the 95th percentile threshold for any of the included racial and ethnic groups.

Overall, rural ZCTAs, compared to urban ZCTAs with in the same MRG category, are much more likely to lack a hospital-based obstetric unit within 15 and 30 road miles (Figure 3; Table 3). Even in areas that do not fall at the 95th percentile for any minoritized group, 24.3% of rural ZCTAs 10.1% of urban ZCTAs lack a hospital obstetric unit within 30 road miles. In rural America, again, AI/AN ZCTAs are the most likely to lack a hospital obstetric unit within 30 miles (51.6%) compared to other rural ZCTAs, followed by those with multiple highly-represented groups (37.8%), those highly represented by White residents (33.8%), Hispanic residents (33.4%), Asian residents (25.6%), those without highly represented groups (24.3%), and those highly represented by Black residents (23.8%). ZCTAs with highly representative Black and Asian residents in both urban and rural areas are more likely to have a hospital obstetric unit within 30 miles than other MRG areas. Yet, 23.8% and 25.6% of rural Black and Asian ZCTAs respectively had to travel more than 30 miles to reach a hospital-based obstetric unit.

CONCLUSIONS

Over 98% of US childbirths occur in hospital settings,²⁰ but travel burdens to reach a hospital with obstetric units vary. Persons living in rural communities, especially rural areas with a high proportion of AI/AN residents, have to travel farther to access a hospital-based obstetric unit than their urban peers. On average, rural ZCTAs are about 20 miles away from a hospital-based obstetric unit—12 miles farther than an average urban ZCTA. Differences in the median distance to access the nearest hospital-based obstetric unit between rural and urban ZCTAs do not reveal the whole

picture of spatial access to hospital obstetric care. Over two-thirds of rural ZCTAs are more than 15 miles away and 27.2% of rural ZCTAs are over 30 miles away from their nearest hospital obstetric unit. In contrast, less than 9% of urban ZCTAs are over 30 miles from a hospital obstetric unit.

Communities with high proportions of AI/AN residents were the most likely to lack a hospital obstetric unit within 30 miles. In urban ZCTA areas with high AI/AN residents, 34.1% had no hospital-based obstetric unit within 15 miles, and this number substantially increased to 80.2% in rural AI/AN areas - suggesting that rural residents in many AI/AN areas are experiencing severe travel burdens to reach any hospital-based obstetric unit. Of note, only 10 out of 29 Indian Health Services (IHS) hospitals having active obstetric units across the United States. In addition, many of these hospitals are inaccessible to AI/AN populations living outside of these tribal or reservation areas.²¹ Geographic disparities in availability of hospital-based obstetric units may constitute an important barrier for reproductive-age families in rural AI/AN areas to receive appropriate obstetric care resulting in disproportionately higher adverse maternal and infant health outcomes.⁷

Rural AI/AN areas are not only farther away from hospital obstetric units but also have lower broadband access and socioeconomic status with higher rates of unemployment, uninsured persons, and poverty compared to rural areas without highly represented MRGs. These social determinants have been widely documented to compromise maternal health^{5,6,22} and, compounded with travel burdens, put these women at even greater risk. AI/AN women have been found to be more likely to be diagnosed with chronic hypertension and diabetes and had higher rates of substance use disorder than their White peers,⁷ leading to higher-risk pregnancies. The combination of lacking access to a hospital obstetric unit and experiencing more preexisting clinical conditions may be associated with AI/AN women experiencing much higher pregnancy-related mortality rates (29.7 per 1,000 births) than non-Hispanic white (12.7), Asian (13.5), and Hispanic (11.5) women.⁷ When looking at severe maternal morbidity – so called “nearly missed” cases - the gap between AI/AN and non-Hispanic White populations widened especially among rural women.⁷

Roughly a third of rural ZCTAs at the 95th percentile for the proportion of Hispanic/Latino residents in their population also are more likely to lack obstetric care within 30 miles. While this is similar to highly represented White rural communities, Hispanic/Latino residents in the US are responsible for much of the in-migration and natural growth in rural communities throughout the country.²³ Fertility rates are higher among rural Hispanic/Latino populations compared to any other geographic and racial/ethnic pairing.²⁴ However, rural Hispanic/Latino MRG areas have much higher uninsured rates than rural areas at the top of the distribution for non-Hispanic White residents or those without MRGs. Safety-net hospitals play an important role in filling in these coverage gaps to provide affordable healthcare to Hispanic/Latino populations. Recent legislative efforts on establishing maternal level of care designation should incorporate safety-net hospitals (e.g., Disproportionate Share Hospitals that receive payments to cover the costs of providing care to uninsured patients but not providing maternity care) for perinatal care regionalization and obstetric care readiness to improve access to perinatal care for all populations.

While Black-White disparities in maternal outcomes are evident,^{1,5,22,25} this study found that areas in the 95th percentile for the proportion of non-Hispanic Black residents are on average closer to the nearest hospital obstetric unit compared to non-highly-represented areas. This could be due, in part, to the fact that ZCTAs with high proportions of rural White residents are in the Midwest and West, where populations are less densely concentrated and ZCTAs are geographically larger. Highly represented rural Black ZCTAs tend to be in the South, where historic patterns of settlement yield geographically smaller ZCTAs with greater population density. Among urban populations, proximity to obstetric care may also be related to Black populations' concentration in older communities near



teaching and/or public hospitals. In addition, Black-White maternal health disparities might be independent of *distances* to a hospital obstetric unit at the community level and instead associated with the social determinants of health.²⁶ Indeed, this study found substantial differences in socioeconomic status between highly represented Black and White ZCTAs. Highly represented Black ZCTAs have nearly two times higher unemployment rates than highly represented White areas or areas without highly represented MRGs. Across rural communities, the average median household income of highly represented Black ZCTAs was less than \$30,000, compared to \$36,642 in White areas with over half of rural highly represented Black areas having more than 52% of residents in poverty. We further found that rural areas with highly represented Black populations have the lowest broadband coverage rates across all rural and urban MRG areas. This is an example of a structural barrier that prevents these communities from benefitting from many federal efforts that have invested in the improvement of access to maternal health care. For example, the Office for the Advancement of Telehealth (OAT)-administered Telehealth Program has successfully leveraged telehealth infrastructure and resources for rural underserved areas.²⁷ In the wake of the COVID-19 pandemic, telehealth has become a promising measure to improve access to care.^{28,29}

It is important to acknowledge that factors beyond driving distance to the nearest hospital-based obstetric unit influence Black-White and Hispanic-White disparities in maternal health outcomes. Rural and urban ZCTAs at the top of the distribution for proportion of White residents were farther away from the nearest hospital obstetric unit than their corresponding Black and Hispanic ZCTAs. Rates for lack of health insurance were much higher in top Black and Hispanic ZCTAs regardless of rurality compared to White or reference ZCTAs. Financial burdens and the associated lack of access to quality maternity care, along with structural racism, likely drive maternal health disparities.^{22,30,31} Pregnant families with low household incomes, homeless or public housing residents, those with low educational attainment, and under- or un-insured families may benefit from increased access to quality maternity care throughout preconception, prenatal, intrapartum, and postpartum care.

Traveling farther to distant hospitals where more specialized maternal and neonatal care is available may be clinically appropriate for high-risk pregnancies. Still, in the case of emergency births, childbirth requires timely attention. Rural women, especially those from highly represented AI/AN areas and/or where the nearest hospital obstetric unit is more than 30 miles away, will need a contingency plan for at-risk pregnancies. For many women in rural and urban AI/AN areas, transferring from home or a nearest hospital to an appropriate hospital obstetric setting with the capacity to offer certain emergency services (e.g., cesarean delivery, neonatal intensive care unit) means more than a 30-mile trip. Since millions of AI/AN women rely on IHS-facilities for health care,³² the IHS National and Area Maternal and Child Health Coordinators play vital roles in regional coordination of maternal and infant care.³³ A clear, smooth, and integrated perinatal care protocol, including high-risk pregnancy screening and perinatal care regionalization, will be required to avoid detrimental outcomes resulting from travel burdens to hospital obstetric units in these rural and AI/AN areas.

Historically, there has been a paucity of policies directly focused on adequate residential proximity to obstetric care. Policymakers seeking to address geographic disparities in hospital-based obstetric care access should tailor their efforts to local community needs and existing perinatal care resources, recognizing the differences across minoritized racial/ethnic groups. Efforts addressing local community needs such as expanding broadband access to eliminate the unequal opportunities of telehealth use for some prenatal care across rural and minoritized race/ethnicity areas, preparing for and mitigating potential hospital-based obstetric unit closures, and allocating resources to cooperative transportation to obstetric care are potential policy levers. Existing perinatal care

resources may be used to develop additional strategies for perinatal care regionalization. This will require an adequate supply of clinicians in areas affected by lack of access to hospital-based obstetric units. State governments have used provider financial incentives to improve adequate access to general medical care including educational and training programs for underserved areas, as well as, scholarship and loan repayment programs.³⁴⁻³⁶ In addition, federal programs such as the National Health Service Corps (NHSC) that encourage clinicians to practice in low-income and rural areas with fellowships and loan payment programs,^{35,37} as well as, the Improving Access to Maternity Care Act (H.R. 1209) of 2018 that aims to identify and address maternity care provider shortage areas, offer promising strategies to help solve the maternity care workforce needs in those communities.³⁸ This study confirms the need to increase community-driven policy solutions that improve access to maternity care in rural America especially those that benefit AI/AN populations.³⁹

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REFERENCES

1. Flanagan A, Frey T, Christiansen SL, AMA Manual of Style Committee. Updated Guidance on the Reporting of Race and Ethnicity in Medical and Science Journals. *JAMA*. 2021;326(7):621–627.
2. Rural and Minority Health Research Center, University of South Carolina. The Problem of the Color Line: Place, race, and access to health care in America. *Health Affairs* February 7, 2022. Available at <https://www.healthaffairs.org/racism-and-health/storymap-the-problem-of-the-color-line>.
3. Eberth JM, Hung P, Benavidez GA, Probst JC, Zahnd WE, McNatt MK, Toussaint E, Merrell MA, Crouch E, Oyesode OJ, Yell N. The Problem Of The Color Line: Spatial Access To Hospital Services For Minoritized Racial And Ethnic Groups. *Health Aff (Millwood)*. 2022 Feb;41(2):237-246.
4. Howell EA, Egorova NN, Balbierz A, Zeitlin J, Hebert PL. Site of delivery contribution to black-white severe maternal morbidity disparity. *Am J Obstet Gynecol*. 2016;215(2):143-152.
5. Howell EA, Egorova N, Balbierz A, Zeitlin J, Hebert PL. Black-white differences in severe maternal morbidity and site of care. *Am J Obstet Gynecol*. 2016;214(1): 122.e1-7.
6. Fingar KR, Hambrick MM, Heslin KC, Moore JE. Trends and disparities in delivery hospitalizations involving severe maternal morbidity, 2006-2015. *H-CUP Stat Br*. 2018;243.
7. Creanga AA, Berg CJ, Syverson C, Seed K, Bruce FC, Callaghan WM. Race, ethnicity, and nativity differentials in pregnancy-related mortality in the United States: 1993–2006. *Obstet & Gynecol*. 2012;120(2 Part 1):261-268.
8. Howell EA. Reducing disparities in severe maternal morbidity and mortality. *Clin Obstet Gynecol*. 2018;61(2):387.
9. Singh, Gopal K. Maternal mortality in the United States, 1935-2007: Substantial racial/ethnic, socioeconomic, and geographic disparities persist. US Department of Health and Human Services, Health Resources and Services Administration, 2010.
10. Kozhimannil KB, Interrante JD, Tofte AN, Admon LK. Severe maternal morbidity and mortality among indigenous women in the United States. *Obstet Gynecol*. 2020;135(2):294-300.
11. National Advisory Committee on Rural Health and Human Services. Maternal and Obstetric Care Challenges in Rural America.; 2020. Accessed on August 2, 2021 from: <https://www.hrsa.gov/sites/default/files/hrsa/advisory-committees/rural/publications/2020-maternal-obstetric-care-challenges.pdf>
12. Kozhimannil KB, Hung P, Henning-Smith C, Casey MM, Prasad S. Association between loss of hospital-based obstetric services and birth outcomes in rural counties in the United States. *JAMA*. 2018;319(12):1239-1247.
13. Hung P, Henning-Smith CE, Casey MM, Kozhimannil KB. Access to obstetric services in rural counties still declining, with 9 percent losing services, 2004-14. *Health Aff*. 2017;36(9):1663-1671.
14. Hung P. Determinants of Obstetric Unit Closure in US Hospitals 2002-2013.; University of Minnesota, Twin Cities, 2017.
15. Hung P, Kozhimannil K, Henning-Smith C, Casey M. Closure of Hospital Obstetric Services Disproportionately Affects Less-Populated Rural Counties. The University of Minnesota Rural Health Research Center.; 2017.
16. Kozhimannil KB, Interrante JD, Tuttle MKS, Henning-Smith C. Changes in hospital-based obstetric services in rural US counties, 2014-2018. *JAMA*. 2020;324(2):197-199.
17. Sullivan MH, Denslow S, Lorenz K, Dixon S, Kelly E, Foley KA. Exploration of the Effects of Rural Obstetric Unit Closures on Birth Outcomes in North Carolina. *J Rural Heal*.

- 2021;37(2):373-384.
18. Centers for Medicare and Medicaid Services. Improving Access to Maternal Health Care in Rural Communities.; 2019. Accessed on August 2, 2021 from: <https://www.cms.gov/About-CMS/Agency-Information/OMH/equity-initiatives/rural-health/09032019-Maternal-Health-Care-in-Rural-Communities.pdf>
 19. U.S. Department of Agriculture Economic Research Service. Rural Urban Commuting Areas Codes. Available at <https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx> Lorch SA, Srinivas SK, Ahlberg C, Small DS. The impact of obstetric unit closures on maternal and infant pregnancy outcomes. *Health Serv Res.* 2013;48(2 Pt 1):455-475.
 20. Office of the Surgeon General. The Surgeon General's Call to Action to Improve Maternal Health. Accessed June 7, 2021. Available from: <https://orwh.od.nih.gov/sites/orwh/files/docs/call-to-action-maternal-health-surgeon-general.pdf>
 21. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Division of Behavioral and Social Sciences and Education; Board on Children, Youth, and Families; Committee on Assessing Health Outcomes by Birth Settings; Backes EP, Scrimshaw SC, editors. Birth Settings in America: Outcomes, Quality, Access, and Choice. Washington (DC): National Academies Press (US); 2020, Maternal and Newborn Outcomes by Birth Setting. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK555483/>
 22. Flanagan A, Frey T, Christiansen SL, Committee AMAM of S. Updated guidance on the reporting of race and ethnicity in medical and science journals. *JAMA.* 2021;326(7):621-627.
 23. MacDorman MF, Declercq E. Trends and state variations in out-of-hospital births in the United States, 2004-2017. *Birth.* 2019;46(2):279-288. doi:10.1111/birt.12411
 24. Grimm CA. Instances of IHS Labor and Delivery Care Not Following National Clinical Guidelines or Best Practices. U.S. Department of Health and Human Services, Office of Inspector General; 2020. Available from: <https://oig.hhs.gov/oei/reports/OEI-06-19-00190.asp>
 25. Singh GK. Trends and social inequalities in maternal mortality in the United States, 1969-2018. *Int J MCH AIDS.* 2021;10(1):29-42.
 26. Lichter DT, Johnson KM. A demographic lifeline? immigration and hispanic population growth in rural America. *Popul Res Policy Rev.* 2020;39(5):785-803.
 27. Ely DM, Hamilton BE. Trends in fertility and mother's age at first birth among rural and metropolitan counties: United States, 2007-2017. US Department of Health and Human Services, Centers for Disease Control and Prevention; 2018.
 28. Gillispie-Bell V. The contrast of color: why the black community continues to suffer health disparities. *Obstet Gynecol.* 2021;137(2):220-224.
 29. Probst JC, Laditka SB, Wang J-Y, Johnson AO. Effects of residence and race on burden of travel for care: cross sectional analysis of the 2001 US National Household Travel Survey. *BMC Health Serv Res.* 2007;7(1):1-13.
 30. Federal Office of Rural Health Policy. Telehealth Programs. Health Resources and Services Administration. Accessed on July 14, 2021. Available from: <https://www.hrsa.gov/rural-health/telehealth>
 31. Fryer K, Delgado A, Foti T, Reid CN, Marshall J. Implementation of obstetric telehealth during COVID-19 and beyond. *Matern Child Health J.* 2020;24(9):1104-1110.
 32. Aziz A, ZorkN, AubeyJJ, et al. Telehealth for high-risk pregnancies in the setting of the COVID-19 pandemic. *Am J Perinatol.* 2020;37(8):800-808.
 33. Fernandez TurienzoC, Newburn M, Agyepong A, et al. Addressing inequities in maternal

- health among women living in communities of social disadvantage and ethnic diversity. *BMC Public Health*. 2021;21(1):176.
34. Browne DR, Hackett S, Burger A. Employing community voices: informing practice and programming through Camden Healthy Start focus groups. *Matern Child Health J*. 2017;21(1):101-106.
 35. U.S. Department of Health and Human Services Indian Health Services. *Trends in Indian Health: 2014 Edition.*; 2014.
 36. Waxman AG, Haffner WHJ, Howe J, et al. A 50-year commitment to American Indian and Alaska Native women. *Obstet Gynecol*. 2020;136(4):739-744.
 37. Pathman DE, Konrad TR, King TS, Taylor DHJ, Koch GG. Outcomes of states' scholarship, loan repayment, and related programs for physicians. *Med Care*. 2004;42(6):560-568.
 38. Pathman DE, Konrad TR. Growth and changes in the National Health Service Corps (NHSC) workforce with the American Recovery and Reinvestment Act. *J Am Board Fam Med*. 2012;25(5):723-733.
 39. Pathman DE, Goldberg L, Konrad TR, Morgan JC. State repayment programs for health care education loans. *JAMA*. 2013;310(18):1982-1984.
 40. Nagaraj M, Coffman M, Bazemore A. 30% of recent family medicine graduates report participation in loan repayment programs. *J Am Board Fam Med*. 2018;31(4):501-502.
 41. Public Law. Improving Access to Maternity Care Act of 2018. House - Energy and Commerce | Senate - Health, Education, Labor, and Pensions; 2018:H.R. 315. <http://www.midwife.org/Improving-Access-to-Maternity-Care-Act-of-2014>
 42. Ma A, Sanchez A, Ma M. The impact of patient-provider race/ethnicity concordance on provider visits: updated evidence from the Medical Expenditure Panel Survey. *J racial Ethn Heal disparities*. 2019;6(5):1011-1020.
 43. U.S. Census Bureau. Explore Census Data. <https://data.census.gov/cedsci/>. Accessed August 4, 2021.
 44. United States Department of Agriculture Economic Research Service. Rural-urban commuting area codes. Rural Classifications. Published 2019. Accessed August 14, 2021. <https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx>
 45. American Academy of Family Physicians. ZIP Code to ZCTA Crosswalk. <https://udsmapper.org/zip-code-to-zcta-crosswalk/> Accessed August 3, 2021.

APPENDIX

Methodology

Data Sources

Data on the racial/ethnic composition of ZCTAs and their socioeconomic conditions comes from the U.S. Census Bureau's American Community Survey, 5-year estimates.⁴⁰ Locations of nationwide hospital-based obstetric units are from the 2019 American Hospital Association Annual Survey. Obstetric unit provision was mainly derived from the 2019 AHA Annual Survey but complemented using the 2019 Centers for Medicare and Medicaid Services (CMS) Provider of Services (POS) Files and hospital websites (more details in the key definitions below.)

Key Definitions

Rurality: Rurality was defined using the ZIP Code approximated Rural Urban Commuting Area (RUCA) codes.⁴¹ Specifically, ZCTAs were assigned the RUCA code for the matching ZIP, even if additional ZIP codes were included in the creation of the ZCTA boundary. Those ZCTAs with a ZIP matched RUCA code of 1-3 were designated as urban while those with a RUCA code of 4-10 were designated as rural. This corresponds to the Office of Management and Budget metropolitan/nonmetropolitan distinction.

The Uniform Data System (UDS) Mapper was used to identify the corresponding ZCTA for each ZIP code.⁴² The UDS Mapper is a mapping tool operated primarily by data from the Uniform Data System to analyze service area of health centers. Since the U.S. Census Bureau does not release an official crosswalk between ZIP Codes and ZCTAs, the UDS Mapper was used to identify ZCTAs using patient data that was matched from the Uniform Data System. Each ZCTA code was added to the dataset using a left join via ZIP codes. Since there were multiple ZIP codes for some ZCTA codes, unique CMS Certification Numbers (CCN's) were counted for each ZCTA code. The procedure worked well, as there were no ZIP Codes used for multiple ZCTA codes.

Hospital-based obstetric units: The provision of obstetric services was defined as all of the following services reported in the AHA Annual Survey: self-reported provision of obstetric services (labor and delivery care), at least level 1 status for maternity care (that is, the provision of services for uncomplicated maternity and newborn cases), at least one dedicated obstetric bed in the hospital, and at least ten births per year. A total of 594 hospitals with discrepancies across the four columns were imputed using the CMS POS Files where obstetric services were coded as 1) no services, 2) provided by staff (i.e., hospital employed physicians), 3) provided by arrangement (e.g., physician contracts), and 4) provided both by staff and arrangements. Additional 18 hospitals which had missing obstetric services status in both AHA and POS files were manually coded based on the hospital websites using hospital names and location addresses in website searches.

Spatial accessibility: After identifying nationwide hospital-based obstetric units, we calculated the one-way trip driving distances in miles from each residential ZCTA centroid from the 2015-2019 American Community Survey to the nearest hospital-based obstetric unit's location per hospital longitude and latitude using the MapQuest application. There are many potential routes driving between each residential ZCTA centroid to a nearest hospital-based obstetric unit. We report driving distances using the fastest road distance per the maximum official driving speed limits.

Minoritized racial/ethnic groups: To classify ZCTAs as high MRG ZCTAs we used the national 95th percentile of each minoritized racial/ethnic groups population proportion stratified by rural/urban status (See Table 1 in the brief for each MRG threshold). Specifically, we ranked all rural and urban ZCTAs based on the proportions of residents who self-identified as Black/African American, Hispanic/Latino, and American Indian/Alaska Native, Asian and then identified ZCTAs with proportions higher than the national 95th percentile in each race/ethnicity group. ZCTAs that fell into multiple MRG groups were categorized into a separate stratum. In addition, among ZCTAs that are not with high (> 95th percentile) MRG residents, we identified those in the 95th percentile for non-Hispanic white residents to distinguish ZCTAs with all Whites from ZCTAs without highly represented race/ethnicity groups.

Demographic characteristics of top MRG ZCTAs

Top MRG ZCTAs could differ from other ZCTAs in the U.S. on characteristics that affect both demand for and local ability to support and retain obstetric services. To provide context for our results, we compared top MRG ZCTAs, defined as those in the 95th percentile for the proportion of each group to all other ZCTAs (labeled “all other;” Table A-1, next page).

- The proportion of the population that may potentially have children can influence local need for obstetric services. On average, both rural and urban MRG areas have much higher proportions of reproductive-age women than non-MRG areas.
- High proportions of uninsured persons within a population can reduce the willingness of providers to locate in or near the area. The proportion of the population lacking health insurance was higher among most MRG ZCTAs than the “all other” group. High A/PI and high White ZCTAs had lower rates for uninsurance.
- Broadband access is important for residents’ ability to access telehealth and telemedicine services as a supplement to pre- and post-natal care.
 - All rural ZCTAs, within each racial/ethnic category, had a lower proportion of households with broadband access than among the equivalent urban ZCTAs.
 - Within urban and rural places, all top MRG ZCTAs except the A/PI group had lower access to broadband than the “all other” category. Within top rural Black ZCTAs, only 58.2% of households reported broadband access.
- Community poverty can make an area unattractive for health care providers of all kinds as persons who are uninsured or whose care is funded by lower-paying insurers, such as Medicaid, offer lower payment for the provider. The proportion of households with incomes at or below 200% of the Federal Poverty Level were higher among MRG ZCTAs than the “all other” group, for all except high A/PI ZCTAs.

Even within the “minoritized population” category, rural ZCTAs can experience disadvantage when compared to urban ZCTAs in the same population group. With some exceptions, noted in the table, ALL rural metrics differ significantly and in a direction of greater disadvantage, than the corresponding values for urban MRG ZCTAs.

Table A-1. Characteristics of Top MRG ZCTAs when compared to all other ZCTAs, by rurality,¹ in percent (Data from the 2015-2019 American Community Survey)

| | Population characteristics | | | | | | Household characteristics: | | | |
|--------------------------------|----------------------------|-----|-----------------------|-----|-------------------|-----|----------------------------|-----|----------------------------|-----|
| | Females age 15 – 44 | | Lack health insurance | | Unemployment rate | | Have broadband | | 200% Federal Poverty Level | |
| Rural ZCTAs (14,875) | % | | | | % | | | | | |
| Hispanic (594) | 33.9% | *** | 15.1% | *** | 6.9% | | 68.5% | *** | 45.4% | *** |
| NH Black (709) | 33.2% | *** | 12.6% | *** | 8.9% | *** | 58.2% | *** | 51.6% | *** |
| NH Am. Ind./ Alaska Nat. (668) | 32.1% | *** | 20.5% | *** | 12.6% | *** | 60.9% | *** | 49.5% | *** |
| NH Asian (622) | 32.4% | ** | 7.4% | *** | 5.2% | | 78.1% | *** | 32.8% | * |
| NH White (2,177) | 23.3% | *** | 7.5% | *** | 4.5% | ** | 71.9% | *** | 35.2% | * |
| >1 MRG (156) | 32.6% | *** | 15.6% | *** | 8.0% | *** | 66.6% | *** | 45.0% | *** |
| All other ZCTAs (9,949) | 26.8% | | 8.4% | | 4.7% | | 74.4% | | 34.4% | |
| Urban ZCTAs (17,795) | | | | | | | | | | |
| Hispanic (755) | 27.8% | ** | 17.0% | *** | 6.7% | *** | 73.8% | *** | 48.1% | *** |
| NH Black (874) | 30.4% | *** | 11.3% | *** | 10.0% | *** | 68.7% | *** | 49.0% | *** |
| NH Am. Ind./ Alaska Nat. (825) | 28.2% | *** | 11.2% | *** | 6.4% | | 74.8% | *** | 36.7% | *** |
| NH Asian (851) | 28.4% | ** | 5.3% | *** | 4.5% | *** | 89.0% | *** | 21.65 | *** |
| NH White (1,203) | 23.7% | *** | 6.6% | ** | 4.8% | * | 75.6% | *** | 31.8% | *** |
| >1 MRG (127) | 27.0% | ** | 14.6% | *** | 7.1% | *** | 74.5% | *** | 49.3% | *** |
| Referent ZCTAs (13,160) | 26.2% | | 7.2% | | 4.6% | | 82.3% | | 27.1% | |

¹ Note: With the exception of lack of health insurance in >1 MRG rural, ZCTAs, ALL rural values differ significantly from the corresponding urban value.

² NH = Non-Hispanic

³ Statistical indicators: Group differs from Referent ZCTA within either all rural or all urban ZCTAs. * = p < .05; ** = p < .01; *** p < .001

Statistical Analysis

We calculated mean values and standard deviations of ACS estimates across rural-urban and MRG ZCTA groupings. We obtained geographic coordinates (longitude and latitude) of each unique hospital-based location from the 2019 American Hospital Association Annual Survey. Using MapQuest 2013, we calculated road distance in miles from each ZCTA's geographic centroid (an area geographic center) to the nearest hospital-based obstetric units using shortest-route distance approach. To describe spatial access distributions across all rural and urban areas and by MRG ZCTA grouping, we calculated descriptive statistics – median and interquartile of driving distances from corresponding MRG areas' ZCTA centroids to the nearest hospital-based obstetric units and proportions of MRG areas without hospital-based obstetric units within 15 and 30 road miles separately.

Maps were created using ArcGIS Pro Version 2.8, and data analysis used SAS Version 9.4, Cary, NC: SAS Institute Inc.