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Original Scholarship

Structural Factors and Racial/Ethnic Inequities in Travel Times to Acute Care Hospitals in the Rural US South, 2007–2018

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Policy Points:

- Policymakers should invest in programs to support rural health systems, with a more targeted focus on spatial accessibility and racial and ethnic equity, not only total supply or nearest facility measures.
- Health plan network adequacy standards should address spatial access to nearest and second nearest hospital care and incorporate equity standards for Black and Latinx rural communities.
- Black and Latinx rural residents contend with inequities in spatial access to hospital care, which arise from fundamental structural inequities in spatial allocation of economic opportunity in rural communities of color. Long-term policy solutions including reparations are needed to address these underlying processes.

Context: The growing rate of rural hospital closures elicits concerns about declining access to hospital-based care. Our research objectives were as follows: 1) characterize the change in rural hospital supply in the US South between 2007 and 2018, accounting for health system closures, mergers, and conversions; 2) quantify spatial accessibility (in 2018) for populations most at risk for adverse outcomes following hospital closure—Black and Latinx rural communities; and

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3) use multilevel modeling to examine relationships between structural factors and disparities in spatial access to care.

Methods: To calculate spatial access, we estimated the network travel distance and time between the census tract–level population-weighted centroids to the nearest and second nearest operating hospital in the years 2007 and 2018. Thereafter, to describe the demographic and health system characteristics of places in relation to spatial accessibility to hospital-based care in 2018, we estimated three-level (tract, county, state-level) generalized linear models.

Findings: We found that 72 (10%) rural counties in the South had ≥1 hospital closure between 2007 and 2018, and nearly half of closure counties (33) lost their last remaining hospital to closure. Net of closures, mergers, and conversions meant hospital supply declined from 783 to 653. Overall, 49.1% of rural tracts experienced worsened spatial access to their nearest hospital, whereas smaller proportions experienced improved (32.4%) or unchanged (18.5%) access between 2007 and 2018. Tracts located within closure counties had longer travel times to the nearest acute care hospital compared with tracts in nonclosure counties. Moreover, rural tracts within Southern states with more concentrated commercial health insurance markets had shorter travel times to access the second nearest hospital.

Conclusions: Rural places affected by rural hospital closures have greater travel burdens for acute care. Across the rural South, racial/ethnic inequities in spatial access to acute care are most pronounced when travel times to the second nearest open acute care hospital are accounted for.

Keywords: rural hospitals, hospital closures, access to care, hospital mergers, racial and ethnic inequities.

Spatial accessibility, defined as "travel impedance (distance or time) between patient location and service points,"[1] interacts with other dimensions of health care services access—such as affordability, acceptability, and accommodation[2]—to produce or inhibit utilization among patients with a recognized need for care.[3] Prior research has shown that, from a patient perspective, the spatial accessibility of alternative facilities is a more accurate measure of travel burden.[4] Spatial accessibility thus can be applied to not only the nearest but also second nearest hospitals that serve as important options for acute health care for rural residents.[1,5] For rural residents, distance is a key barrier to health care utilization,[6,7] not only impacting the frequency, timing, and cost of hospital visits but also potentially affecting health outcomes.[8,9,10] This has downstream consequences, including hospitalizations for ambulatory care sensitive conditions,[11] longer ambulance travel times,[12–15] and worse survival rates for critical conditions such as heart attacks and unintentional injuries.[16] Among rural residents, longer travel times and distances to care are associated with lower rates of posthospitalization follow-up care, higher rates of emergency department use, delayed diagnoses and worse severity of conditions, and higher mortality.[17–21]

Because time is a social determinant of health (SDoH),[22] travel inequities by race and ethnicity are especially concerning. Under structural racism, non-White people experience a time penalty across myriad facets of life.[22] Time is a resource that is socially patterned, and this patterning is fundamentally shaped by the spatial allocation of key resources, including health care services. Black and Latinx people in the United States experience high degrees of time scarcity[23] attributable, in part, to their disproportionate occupational sorting into jobs that do not offer employer-sponsored insurance,[24–26] longer work commutes borne of spatial mismatch between where they live and work[27,28]—which forces a trade-off among wages, commute times, and housing affordability[29]—and longer travel distances to needed care.[30] In terms of health care access, compared with insured White patients, insured Black patients are more likely to experience higher administrative burdens (defined as the learning, psychological, and compliance costs experienced by citizens or other users of services in the course of navigating bureaucracies and associated policies, e.g., health care insurance)[31p23] associated with using health care, which increases the likelihood of forgone care.[32] Moreover, in addition to longer wait times for needed care,[33,34] Black and Latinx workers are less likely to receive paid sick leave through their jobs,[35] which amplifies the monetary and temporal costs of accessing care, including direct and indirect costs such as forgone income. Travel burdens to acute care hospitals thus merit greater investigation as a compounding feature of structural racism in socioeconomic, housing, and health policy, which produces health care inequities.[26]

Prior research on hospital utilization also points to the need to examine racialized differences in spatial accessibility and time burdens. A recent study in Florida found that Black and Latinx patient outcomes are more sensitive to travel time than those of White residents.[36] Specifically, the probability of inpatient hospitalization dropped off more steeply, at shorter travel times (10 minutes versus 15 minutes), suggesting that travel burdens may be more consequential for Black and Latinx populations.[36] Hospital bypass literature also points to racialized differences in the significance and conceptualization of spatial accessibility. Members of more privileged groups—those who are White, privately insured, and college educated—are more likely to bypass rural hospitals to seek care in urban centers.[37,38] In a study of rural patients who bypassed their nearest hospital for outpatient procedures, Saunders and colleagues found that White and more affluent patients were more likely to receive care at ambulatory surgery centers, whereas non-White patients received care at hospital outpatient departments.[39] Multiple studies on where patients receive care have also found that Black patients are more likely to receive care at lower-quality hospitals, even when the nearest hospital has higher-quality and/or more services. Other factors, including racial and economic segregation, hospital Medicaid share, physician referral patterns, prior experiences, and community trust, are associated with hospital selection and bypass behaviors net of proximity.[40,41] In summary, spatial accessibility to hospital care—and to more than one hospital—is particularly salient for Black and Latinx populations in rural areas.

Since 1990, approximately 15% of all hospitals in the United States have closed;[42] since 2011, the number of hospital closures in the United States has exceeded the number of newly opened hospitals.[43] From 1990 to 2020, 334 rural hospitals closed in the United States.[44] Under worsening economic inequality, particularly since the Great Recession of 2008, rural hospitals have been vulnerable to financial distress and closure.[45] Because they are located in areas with declining populations,[46] older residents, relatively higher rates of poverty, and concurrent lower rates of private insurance coverage, rural hospitals have a greater reliance on public payers (Medicare and Medicaid) than their urban counterparts.[47] States that have not expanded Medicaid after the Affordable Care Act are home to the majority of Black residents in the United States,[48] and their hospitals are particularly at risk for closure.[47] In addition, the growing prevalence of high-deductible insurance plans among rural residents has led to rising unpaid medical debt among low-income patients, and correspondingly, lost revenue for rural hospitals.[49] These challenges have contributed to the overall decline of rural hospital margins, and their markedly worse financial stability.[50]

Prior studies have found that after hospital closures, rural residents experienced increased travel times, decreased utilization of inpatient emergency services, and loss of specialty care.[14,51,52] Moreover, hospital closures comprise just one aspect of declining acute care inpatient services in rural areas[53]; even if facilities stay open, they may shift to emphasize outpatient care,[43] discontinue some services lines, or convert to other types of providers, such as emergency centers or long-term care facilities.[44] Closure of hospital-based obstetric wards in rural areas has been associated with reduced access to and use of prenatal care and increased risk of adverse birth outcomes.[9,54] In addition, rural hospital closures are associated with an overall decline in the supply of health care workers in rural areas, suggesting downstream impacts on access to ambulatory services.[55]

Although recent research on rural hospital closures has described changes in health care supply across geographic areas,[56] there has been limited examination of how these changes affect spatial access to care.[51] Unlike area-level counts of facilities and providers (also known as "container methods"), population-based measures of travel distance and travel times avoid encoding the assumption that patients only use services that are contained within the areal unit (e.g., county or ZIP code) in which they live. First, residents of rural communities may live closer to hospitals in a different county than their county of residence; therefore, total supply does not reflect what is spatially accessible. Second, spatial proximity to the nearest hospital offers only a partial picture of access to care in rural communities, where the propensity to bypass local hospitals (i.e., traveling to a farther facility to receive care rather than use the closest facility)[57] is high and differentially shaped by services offered, insurance type,[58] condition severity, and local health care provider supply.[59] As rural hospitals close and the range and diversity of services offered at remaining facilities shrink, rural residents' reliance on alternative but geographically accessible facilities such as the second nearest may increase. Thus, measuring spatial accessibility better captures overall shifts in acute hospital access, rather than singular rural hospital closure events. Two prior studies examined the effects of rural hospital closures in the United States on spatial access to care, finding no significant impacts on rural patients' access.[60,61] However, these estimates were based on travel distance between facilities rather than travel between populations and facilities. A recent study by Bell and colleagues found that distance to outpatient safety net providers, e.g., federally qualified health centers (FQHCs), from rural ZIP codes was unchanged after hospital closures; the authors proposed that federal support for FQHC expansion may have offset hospital changes.[62] A 2020 US Government

Accountability Office report found that patients in areas previously served by a closed rural hospital had increased median travel distance to care, from 3.4 miles for general inpatient services in 2012 to 23.9 miles in 2018 (a 20.5-mile increase in six years), with lower utilization of health services among Medicare beneficiaries.[15] None of these studies examined spatial accessibility to additional hospitals beyond the nearest facility.

Furthermore, although simulation studies have modeled potential changes in access to care after hospital rural hospitals close,[63] none to date have been attentive to the disparate impacts by race, ethnicity, and socioeconomic status. Thus, relatively little is known about racial and ethnic inequities in spatial access to care in the context of rural hospital closures. This is notable because since 1990, rural counties with hospital closures have had higher shares of Black and Hispanic residents,[64] potentially compounding other health care access inequities, including longer travel burdens, lower receipt of preventive care, and persistent shortages of health care professionals.[65]

Recent studies have only accounted for hospital system closures, not the extent to which loss of acute care can also be driven by other status changes, such as mergers and conversions to other types of facilities.[66,67] We focused on the US South because it is a racially and ethnically diverse region that is home to a majority (approximately 56%) of Black people in the United States as of 2019.[47] Additionally, the region accounted for over 60% of rural hospital closures across the country from 2005 to 2020.[64,68] At the same time, the rural US South is a region whose residents bear heavy burdens of chronic illness and disability, burdens potentially compounded by both longer distances to access care[7] and the impacts of hospital closures.[47] Racial inequities in health care access and quality in the South also contribute disproportionately to the national picture.[69]

Therefore, our objectives for this study are as follows.

Objective 1: To characterize the change in rural hospital supply in the US South from 2007 to 2018, accounting for facility closures due to health system closures, mergers, and conversions, and to examine subsequent changes in travel time and distance to acute care hospitals when accounting for both rural and urban hospitals.

Objective 2: To describe spatial accessibility, defined as travel distance and time, to nearest and second nearest acute care hospitals in 2018 and assess inequities related to characteristics of populations most at risk for adverse outcomes after hospital closure, i.e., Black and Latinx communities[56] and those living in the most rural/remote counties. We specifically examined accessibility to both the nearest and second nearest acute care hospital to account for rural residents' use of regional, not only local, hospitals. As with objective 1, we included spatial access to rural and nonrural hospitals because rural residents are increasingly admitted to urban hospitals for inpatient care.[70]

Objective 3: To examine relationships among populations at risk (Black, Latinx, most rural/remote) and spatial accessibility to acute hospital care. Spatial accessibility may be conditioned on multiple factors that drive acute care needs and health system revenues, so we used multilevel models to estimate relationships among racial and ethnic composition, rurality, and spatial access to care, accounting for tract and county socioeconomic and demographic characteristics as well as state health care market and policy environment. Furthermore, to the extent that structural racism impacts the geographic allocation of other structural factors, we examined whether degree of rurality modifies associations between racial and ethnic composition and spatial accessibility. The findings highlight racially disparate downstream consequences that structure both health and health care inequities borne by rural communities of color—especially Black and Latinx communities.[71]

Methods

Sample

The study sample for this analysis is populated census tracts ($n = 3{,}511$) nested within 720 rural counties in the US South region (defined as comprising Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Tennessee, Kentucky, Virginia, North Carolina, South Carolina, Georgia, and Florida), which included 12.6 million rural residents in 2018 (US Census Bureau, American Community Survey (ACS), five-year estimates 2014 to 2018).

Data and Measures

We obtained locations of rural short-term acute care hospital closures and mergers in the region for the years 2007 and 2018 from the

University of North Carolina Sheps Center for Health Services Research[44] and verified the closures through triangulation between news reports and the Centers for Medicare and Medicaid Services Provider of Services data set. We used the American Hospital Association Annual Survey to obtain locations of all urban and rural acute care short-term hospitals (including critical access hospitals) that remained open in the fiscal years of 2007 and 2018. We also checked the list of open hospitals against the list of closed hospitals to verify the accuracy of the hospital closures data set. We then geocoded the facility addresses of all hospitals, both those that closed and those operating continuously, between 2007 and 2018. We then categorized counties by hospital count and closure status as follows: no hospital in 2007; one or more hospitals in 2007, with a closure as of 2018; or one or more hospitals in 2007, with no closures as of 2018.

To measure spatial accessibility, we used a geographic information system (GIS) software—ArcGIS 10.8—to estimate travel distance and driving time to the nearest and second nearest hospital (whether urban or rural) from each census tract population-weighted centroid in 2007 and 2018. Travel times were derived from GIS-based network distance calculations, based on current road networks and their speed limits for the given year. To calculate changes in travel time, we examined the subsample of rural tracts whose population-weighted centroids could be spatially matched across the years 2007 and 2018, ($n = 3{,}511$). Changes in travel time were classified by three categories: worsened (change in travel time >2 minutes), unchanged (change ≥ -2.0 to $\leq +2.0$ minutes), and improved (shorter travel time, change < -2.0 minutes). The two-minute cutoff was chosen to omit small changes in travel time linked to changes in speed limits and other factors that are not associated with hospital closures.

For information on demographic, health systems, and policy characteristics of tracts, we used data from the US Census Bureau ACS (five-year estimates 2014 to 2018), the Dartmouth Atlas of Healthcare, and The Henry J. Kaiser Family Foundation.[72] We used the following tract-level demographic and socioeconomic characteristics: percent Black, Latinx, and White population; income inequality (Gini coefficient); and median household income (continuous). We also categorized tract racial and ethnic composition as high (>59%), moderate ($\geq$30% to $\leq$59%), and low (<30%) for percentage of Latinx, Black, and White residents. We included the tract-level Gini coefficient because prior research shows that area-level income inequality is associated with higher individual unmet health care needs.[73]

We used the following county-level social and demographic measures to characterize populations that would be especially vulnerable to changes in spatial accessibility to hospitals, namely, county-level median age; age dependency ratio (measured as the ratio of nonworking age population ($\geq$65 years or $\leq$15 years) to working age population (15-65 years), which captures the population associated with social and health spending, such as Medicare and Social Security benefits for the $\geq$65 years population); low-income insurance coverage (insured rate for persons aged 18–64 with incomes below 138% of the federal poverty line, 2014–2018); and the 2013 Rural-Urban Continuum Codes (RUCCs), which measure the county-level degree of rurality based on population size, degree of urbanization, and adjacency (Table 1).[74]

At the state level, we included measures of state health care market and policy characteristics that would also impact hospital supply and accessibility, including state Medicaid expansion status as of 2018 and the competitiveness of Affordable Care Act insurance marketplaces (measured as the state-level market share of the largest insurer).[75] We included state Medicaid expansion status because nonexpansion states have experienced both heightened risk of rural hospital closures[76] and loss of general internist physicians to expansion states, which has particularly affected rural and small towns in nonexpansion states.[77] Notably, nonexpansion states are clustered in the US South region, which is home to the majority of Black residents in the United States.[78] Highly concentrated insurance markets are associated with lower hospital prices and higher financial risk borne by hospitals.[79]

Analytic Approach

For objective 1, we summarized the total supply of hospitals in rural counties in the US South in 2007 and 2018. We then described demographic, socioeconomic, and health care characteristics of tracts by type of change in spatial accessibility to nearest acute care hospital (worsened, no change, or improved) from 2007 to 2018. For objective 2, we described travel distance and time to nearest and second nearest acute

Table 1. **Characteristics of US Census Tracts in the Rural South in 2018, Counties and States, by Change in Mean Travel Time to Nearest Acute Care Hospital From 2007 to 2018; $n = 3{,}511$ Tracts in $n = 720$ Counties**

		Change in Tract-Level Spatial Access, 2007–2018		
Tract characteristics	**Total *n* (SD or %)**	**Worsened**	**Unchanged**	**Improved**
Number of tracts	3,511 (100%)	1,725 (49.1%)	649 (18.5%)	1,137 (32.4%)
2018 population	12,290,186 (100%)	6,074,284 (49.4%)	2,866,355 (23.3%)	3,349,547 (27.3%)
Population change since 2007, mean (SD)	+0.69% (8.9)	+4.1% (13.2)	−0.92% (5.5)	+3.5% (14.8)
Latinx share of population[a]	16.5% (58.2)	15.4% (20.1)	18.6% (24.5)	17.1% (19.1)
Black share of population	17.5% (22.2)	17.5% (21.7)	17.6% (22.2)	17.2% (21.7)
White share of population	76.2% (22.5)	76.0% (22.3)	76.6% (22.4)	76.3% (21.9)
Median age	41.3 (6.7)	41.2 (6.8)	41.3 (6.5)	41.1 (6.9)

Continued

Table 1. (Continued)

		Change in Tract-Level Spatial Access, 2007–2018		
Tract characteristics	**Total *n* (SD or %)**	**Worsened**	**Unchanged**	**Improved**
Median household income	$43,335 (16,061)	$42,855[b] (14,567)	$43,492 (13,029)	$43,993 (19,437)
Income inequality (Gini coefficient)	0.45 (0.06)	0.45 (0.06)	0.45 (0.06)	0.45 (0.06)
County characteristics				
County hospital status (2007-2018)[c]	*n* (%)	Worsened	Unchanged	Improved
No hospital since 2007	334 (9.5%)	94 (28.1%)	40 (12.0%)	200 (59.9%)
≥1 hospital closure since 2007	316 (9.0%)	157 (49.7%)	57 (18.0%)	102 (32.3%)
≥1 hospital; no closure since 2007	2,861 (81.5%)	1,474 (51.5%)	552 (19.3%)	835 (29.2%)
Degree of rurality (RUCCs 2013)[d]				
4	609 (17.3%)	294 (48.3%)	106 (17.4%)	209 (34.3%)
5	226 (6.4%)	109 (48.2%)	41 (18.1%)	76 (33.6%)
6	1,424 (40.6%)	709 (49.8%)	280 (19.7%)	435 (30.5%)
7	712 (20.3%)	345 (48.5%)	125 (17.6%)	242 (34.0%)

Continued

Table 1. (Continued)

Tract characteristics	Total *n* (SD or %)	Change in Tract-Level Spatial Access, 2007–2018		
		Worsened	Unchanged	Improved
8	281 (8.0%)	137 (48.8%)	52 (18.5%)	92 (32.7%)
9	259 (7.4%)	131 (50.6%)	45 (17.4%)	83 (32.0%)
State characteristics				
Medicaid expansion status (2018)		Worsened	Unchanged	Improved
Expanded	920 (26.2%)	420 (45.7%)	154 (16.7%)	346 (37.6%)
Not expanded	2,591 (73.8%)	1,304 (50.3%)	497 (19.2%)	790 (30.5%)

Abbreviation: RUCCs, Rural-Urban Continuum Codes.
[a] Because of census data suppression at the tract level, the analytic sample dropped to 2,877 tracts when we accounted for the Latinx population share.
[b] $P < 0.01$.
[c] This is a categorical variable reporting [Count(Proportion)] that measures the change in travel distance to the nearest operating hospital between the years 2007 and 2018.
[d] RUCC 2013 codes for nonmetro counties are as follows.
4: Nonmetro—Urban population of 20,000 or more, adjacent to a metro area.
5: Nonmetro—Urban population of 20,000 or more, not adjacent to a metro area.
6: Nonmetro—Urban population of 2,500 to 19,999, adjacent to a metro area.
7: Nonmetro—Urban population of 2,500 to 19,999, not adjacent to a metro area.
8: Nonmetro—Completely rural or less than 2,500 urban population, adjacent to a metro area.
9: Nonmetro—Completely rural or less than 2,500 urban population, not adjacent to a metro area.

care hospitals in 2018, by tract social and geographical characteristics, including race and ethnicity, and rurality. The statistical significance of the pairwise comparisons were tested using chi-square tests ($\alpha < 0.05$).

For objective 3, we used three-level mixed effects generalized linear regression models to estimate associations among demographic, socioeconomic, health care and policy factors, and network travel time to the nearest and second nearest hospitals. We explicitly modeled distinct variables at each level because we hypothesize that 1) the factors operate at different geographic scales and 2) the effects are not homogenous across levels.[80]

The first model examines tract-level driving time to the nearest hospital, and the second model focuses on driving time to the second nearest hospital. Both models include the same covariates at the tract, county, and state levels, plus random intercepts for county and state. This nested approach is consistent with recent findings that census tract–level socioeconomic and demographic variables accounted for up to three-fourths of between-state variation in health outcomes and 58% of between-county variation.[81] The statistical modeling framework anticipates that tract-level spatial access to acute care is partly a function of the county and state within which tracts are located.[82]

Notably, after fitting the three-level generalized linear model, we estimated the variable inflation factors (VIFs) to rule out multicollinearity between the tract shares of Black and Latinx residents (mean VIF for our models ranged from 1.38 to 1.44, which is well below the threshold for moderate multicollinearity (VIF $\geq$ 5)). In addition, because of suppression of ethnicity data (i.e., proportion of Latinx residents) at the tract level, the analytic sample for the three-level generalized linear models was reduced to 2,877 tracts.

Additionally, we tested cross-level interaction terms to estimate the degree to which county characteristics modify the effect of the tract characteristics. Because the most profound health care shortages occur in rural Black communities,[83] we tested cross-level interactions between the tract percentage of Latinx and Black residents (separately) and the county-level RUCC. This approach addressed our hypothesis that certain factors, such as degree of rurality, would have disproportionate impacts on Black and Latinx communities. We then estimated the marginal effects of tract Black and Latinx population and rural context on spatial access. Analyses were conducted using Stata 17.[84]

Results

Objective 1: Changes in Acute Care Hospital Supply in the US South

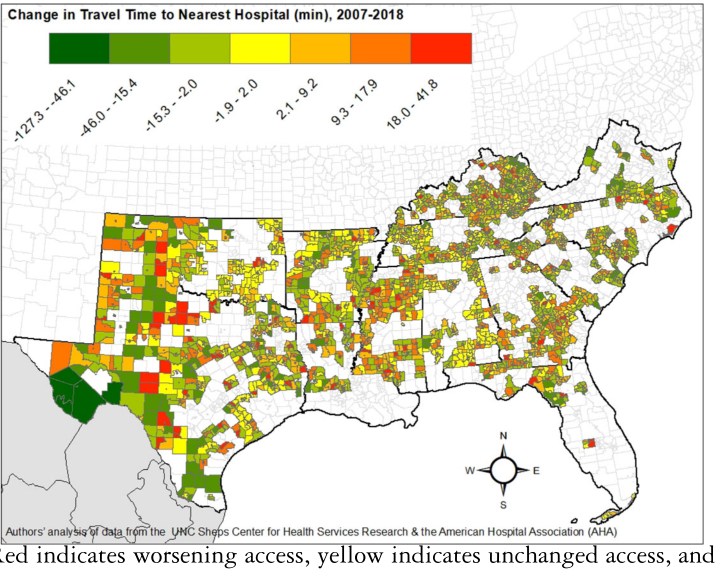
Between 2007 and 2018, 74 hospitals formally closed in rural counties in the US South, but the total supply of hospitals, when accounting for mergers and conversions, declined from 783 to 653 for a net loss of 130 hospitals. Of all rural counties in the South, 10% (72) had at least one closure, and nearly half of closure counties (33/72, or 45.8%) lost their last hospital to closure between 2007 and 2018. These rural hospital closures contributed to the overall increase in rural counties with zero hospitals (up to 218 counties in 2018, from 177 in 2007).

Overall, 49.1% of rural tracts in the US South experienced worsened spatial access (increased travel time) to their nearest hospital, whereas a smaller proportion experienced improved spatial access (32.4%) and unchanged access (18.5%; Table 1). In terms of population, 49.4% (approximately 6.1 million) of rural residents in the US South resided in tracts where spatial access to acute hospitals worsened between 2007 and 2018, compared with 27.3% (3.3 million) in tracts where access improved and 23.3% (2.9 million) in tracts where access was unchanged. The changes in travel times ranged from a decrease of 127.2 minutes (105.8 miles) for a tract in western Texas that gained a new hospital nearby to an increase of 41.0 minutes (45.1 miles) for a tract in Florida's panhandle (Figure 1).

Accordingly, between 2007 and 2018, the tract-level mean travel distances and travel times to the nearest and second nearest acute hospital in the rural South increased. The mean travel distance to the nearest facility increased from 9.85 miles in 2007 to 15.9 miles in 2018. Similarly, the mean travel distance to access the second nearest hospital increased from 14.0 miles to 22.6 miles. These increases in mean travel distances and times occurred despite a much wider spread for travel distance and travel times in 2007 (e.g., the range was 0.98-150.6 miles to access the nearest hospital in the US South in 2007, compared with 0.2-49.5 miles in 2018).

When categorized by rurality, we found minimal differences in the percentage of tracts with worsened spatial access (Table 1). Tracts in the most rural category (RUCC 9) were slightly more likely than others to see a decline in spatial access, but with 50.6% of the most rural tracts

Figure 1. Map of the Tract-Level Change in Travel Time to the Nearest Hospital Between 2007 and 2018.



Red indicates worsening access, yellow indicates unchanged access, and blue indicates improved access since 2007.

experiencing a decline, compared with 48%-50% for the other RUCC categories, the disparity is very small.

Regarding tract demographic and socioeconomic characteristics, we found tracts with worsened access to the nearest acute hospital tended to have lower median household incomes (Table 1; for additional tract, county, and state characteristics, see Appendix, Table A2). Additionally, tracts with worsened access had higher average population growth rates (+4.1% versus +3.5% for tracts with improved access and −0.92% for tracts with unchanged access; Table 1). Moreover, rural tracts in states that expanded Medicaid by January 2018 were less likely to experience worsening access and more likely to experience improved access, whereas the percentages are reversed for those in nonexpansion states.

Objective 2: Spatial Access to Hospital Care in the Rural US South in 2018 for Vulnerable Populations

In 2018, the mean travel time and distance to access the nearest acute care hospital were 22.6 minutes and 15.9 miles, respectively. For the second nearest hospital, the corresponding values were 35.5 minutes and 26.4 miles, respectively. Moreover, across the rural South, driving distance and driving time to the nearest hospitals generally increased with degree of rurality, except in the most rural counties (RUCC 9; Table 2). We also found that, although residents in rural tracts within closure counties had comparatively shorter driving times to the nearest hospital (20.6 minutes versus 22.3 minutes in nonclosure counties; $P = 0.0154$), the difference in travel time to the second nearest hospital was not statistically significant (35.5 minutes versus 35.2 minutes in nonclosure counties; $P = 0.9153$). Notably, between 2007 and 2018, closure counties disproportionately neighbored metro areas (RUCCs 4, 6, and 8).

Moreover, in 2018, rural tracts where residents experienced worsened spatial access to acute hospitals had longer mean travel times and travel distances to access their nearest hospital, compared with tracts with improved or unchanged spatial access (15.6 minutes for tracts with worsened access versus 7.7 minutes for tracts with improved access and 7.9 minutes for tracts with unchanged access; Table 3). Average travel times and distances to the second nearest hospital were also longer in tracts in which spatial access declined (28.1 minutes versus 25.1 minutes for tracts with improved access and 24.1 for tracts with unchanged access; Table 3).

By population, approximately 2.9 million residents in 699 (16.3%) rural tracts in the US South had to travel in excess of 30 minutes to access their nearest hospital in 2018 (Appendix, Table A1). In terms of travel time to the second nearest hospital, an estimated 12.7 million residents had travel times exceeding 30 minutes, and of those, 3.5 million residents had travel times in excess of 45 minutes. Put another way, only about 28.1% of rural residents in the US South lived within a 30-minute drive of two acute care hospitals in 2018.

When we examined travel time and distance by tract characteristics, we also found racial and ethnic inequities in spatial access to acute care hospitals. Residents in high share Latinx tracts (defined as $\geq$60%) had the longest travel distances and times to the nearest hospital (mean: 19.1

Table 2. Travel Distance and Time to Nearest and Second Nearest Acute Care Hospital by Tract Characteristics

	Nearest Hospital		Second Nearest Hospital	
	Travel Time (Minutes)	**Travel Distance (Miles)**	**Travel Time (Minutes)**	**Travel Distance (Miles)**
Overall mean travel time and distance	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
2018	15.9 (9.1)	22.6 (10.8)	26.4 (7.8)	35.5 (11.2)
Racial and ethnic composition				
High share Latinx residents (*n* = 207)	19.1 (13.1)	24.3 (13.7)	28.9 (7.5)	38.2 (9.9)
High share Black residents (*n* = 201)	15.4 (8.6)	22.2 (10.1)	28.2 (6.6)	37.4 (8.4)
High share White residents (*n* = 2,763)	16.2 (9.5)	22.8 (11.2)	26.3 (7.9)	35.2 (10.3)
Degree of rurality (RUCCs 2013), 2018				
4 (Nonmetro—Urban population of 20,000 or more, adjacent to a metro area)	10.1 (8.5)	15.6 (10.3)	25.6 (9.1)	34.6 (11.5)
5 (Nonmetro—Urban population of 20,000 or more, not adjacent to a metro area)	8.7 (7.2)	14.1 (9.4)	25.1 (9.2)	33.5 (11.5)

Continued

Table 2. (Continued)

	Nearest Hospital		Second Nearest Hospital	
	Travel Time (Minutes)	Travel Distance (Miles)	Travel Time (Minutes)	Travel Distance (Miles)
Overall mean travel time and distance	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
6 (Nonmetro—Urban population of 2,500 to 19,999, adjacent to a metro area)	11.8 (8.8)	17.9 (11.1)	26.6 (7.5)	35.5 (9.6)
7 (Nonmetro—Urban population of 2,500 to 19,999, not adjacent to a metro area)	12.7 (8.6)	19.1 (11.1)	27.3 (7.6)	36.5 (10.3)
8 (Nonmetro—Completely rural or less than 2,500 urban population, adjacent to a metro area)	13.8 (8.2)	21.0 (10.6)	27.0 (7.0)	36.1 (9.4)
9 (Nonmetro—Completely rural or less than 2,500 urban population, not adjacent to a metro area)	13.6 (8.0)	20.7 (10.1)	27.6 (6.5)	36.9 (8.6)

Abbreviation: RUCCs, Rural-Urban Continuum Codes.

Table 3. Mean Travel Times and Distances to Nearest and Second Nearest Hospital in 2018 by Change in Spatial Access, 2007–2018

Tracts (*n* = 3,511) Within Counties (*n* = 720)

		Change in Tract-Level Spatial Access, 2007–2018		
		Worsened	**Unchanged**	**Improved**
Travel time and distance to access nearest and second nearest hospital, 2018, mean (SD)				
Travel time—nearest	15.9 (8.6.)	15.6 (7.8)	7.9 (6.9)	7.7 (7.3)
Travel distance—nearest	17.9 (10.8)	23.5 (9.4)	12.7 (7.9)	12.2 (9.6)
Travel time—second nearest	26.5 (7.8)	28.1 (6.8)	24.1 (8.2)	25.1 (8.5)
Travel distance—second nearest	35.6 (10.2)	37.4 (9.3)	32.9 (10.6)	33.8 (10.6)

miles, 24.3 minutes) compared with rural tracts with high percentages of Black and White residents. Residents in high share Black tracts had on average shorter travel distances and times (mean: 15.4 miles, 22.2 minutes) to access the nearest acute hospital than those in high share White rural tracts (mean: 16.2 miles, 22.8 minutes; Table 2).

Racial and ethnic inequities were more apparent when we examined travel distances and times to the second nearest hospital. High share White rural tracts had shorter travel to the second nearest hospital (mean: 26.3 miles, 35.2 minutes), compared with high share Black (mean: 28.2 miles; 37.4 minutes) and high share Latinx (mean: 28.9 miles; 38.2 minutes) rural tracts in the US South (Table 2). All of these differences were statistically significant ($P < 0.05$). Moreover, we found that the additional travel time to access the second nearest acute hospital generally increased with the tract-level share of Black residents (Appendix, Figure A1). In contrast, rural tracts with moderate (30.0%-59.9%) shares of Latinx residents had the greatest additional travel times to access the second nearest acute hospital (Appendix, Figure A1).

As for geographic characteristics, tracts located in more rural counties generally had longer travel times and distances, with a couple of exceptions. Tracts within RUCC 5 counties (Nonmetro—Urban population of 20,000 or more, not adjacent to a metro area) had the lowest travel distances and times to the nearest (mean: 14.1 miles, 8.7 minutes) and second nearest hospital (mean: 33.5 miles, 25.1 minutes; Table 2). Tracts within RUCC 8 counties (Nonmetro—Completely rural or less than 2,500 urban population, adjacent to a metro area) had the longest travel distances and times to the nearest (mean: 21.0 miles, 13.8 minutes) and second nearest hospital (mean: 36.1 miles, 27.0 minutes; Table 2). The differences in travel distance and time by rurality were statistically significant ($P < 0.05$).

Objective 3a: Population, Health System, and Policy Characteristics Associated with Travel Time to Nearest Hospital in 2018

When we examined associations between the tract-level driving times to the nearest acute care hospital in 2018 and tract, county, and state characteristics (Table 4), we found that Black share, Latinx share, and median household income were not associated with travel time to nearest

Table 4. Associations Between Travel time to Nearest Acute Care Hospital and Tract ($n = 2{,}877$), County ($n = 720$), and State ($n = 13$) Characteristics, 2018[a]

	Characteristics	β	95% CI		P-Value
Tract					
	Latinx share of population				
	Low share (<30%) (ref)	–	–	–	–
	Moderate share (30%-59.9%)	0.408	−0.959	1.776	0.560
	High share (60%-100%)	0.863	−0.739	2.466	0.291
	Black share of population				
	Low share (<30%) (ref)	–	–	–	–
	Moderate share (30%-59.9%)	−0.711	−1.494	0.073	0.075
	High share (60%-100%)	−0.636	−1.955	0.682	0.344
	Median household income (2014-2018)				
	20th percentile (ref)	–	–	–	–
	40th percentile	0.081	–0.811	0.973	0.859
	60th percentile	–0.431	–1.342	0.480	0.354
	80th percentile	0.127	–0.817	1.070	0.792
	Top quintile	–0.448	–1.440	0.544	0.376
	Gini coefficient (2014-2018)	–0.298	–5.226	4.630	0.906

Continued

Table 4. (Continued)

	Characteristics	**β**	95% CI		***P*-Value**
County	County degree of rurality (RUCCs 2013)[b]				
	4 (ref)	–	–	–	–
	5	−0.839	−2.067	0.390	0.181
	6	−0.003	−0.758	0.752	0.994
	7	−0.054	−0.916	0.808	0.902
	8	1.534	0.385	2.682	0.009*
	9	0.261	−0.932	1.454	0.668
	County closure status 2007–2018				
	≥1 closures (ref)	–	–	–	–
	No closures	−2.088	−4.049	−1.127	0.037*
	Age dependency ratio (2010-2018)				
	Decreased (ref)	–	–	–	–
	Unchanged	−4.898	−11.727	1.930	0.160
	Increased	−0.717	−1.817	0.383	0.202
	Median age (2014-2018)	0.011	−0.0515	0.074	0.728
	Uninsured rate, ages 18–64—county (2014-2018)	−0.013	−0.055	0.023	0.560

Continued

Table 4. (Continued)

	Characteristics	β	95% CI		*P*-Value
State	Medicaid expansion status (2018)				
	Nonexpansion State	–	–	–	–
	Expansion state	−2.169	−5.004	0.666	0.134
	Health insurance market concentration—state (2017)	0.1270	−1.5670	1.822	0.883

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; CI, confidence interval; RUCCs, Rural-Urban Continuum Codes.
*$P < 0.05$.
[a]Model diagnostics: AIC, 19884.51; BIC, 20033.62.
[b]RUCC 2013 codes for nonmetro counties are as follows.
4: Nonmetro—Urban population of 20,000 or more, adjacent to a metro area.
5: Nonmetro—Urban population of 20,000 or more, not adjacent to a metro area.
6: Nonmetro—Urban population of 2,500 to 19,999, adjacent to a metro area.
7: Nonmetro—Urban population of 2,500 to 19,999, not adjacent to a metro area.
8: Nonmetro—Completely rural or less than 2,500 urban population, adjacent to a metro area.
9: Nonmetro—Completely rural or less than 2,500 urban population, not adjacent to a metro area.

acute care hospital at a level of significance of $P < 0.05$, when accounting for other factors in the model (Table 4). Tract location within an RUCC 8 county, relative to RUCC 4 counties, was associated with longer times to the nearest acute care hospital ($\beta = 1.534$; 95% confidence interval (CI): 0.385-2.682; $P = 0.009$). Location in a county with no hospital closure was associated with shorter travel time to the nearest acute care hospital compared with those in closure counties ($\beta = -2.088$; 95% CI: -4.049 to -1.127; $P = 0.037$). In other words, tracts located in counties with hospital closures in the previous decade had longer travel times than tracts without.

When we examined interaction terms by tract Black and Latinx population share and county RUCC level (separately), we found no significant main effects or interaction terms.

Objective 3b: Population, Health System, and Policy Characteristics Associated with Travel Time to Second Nearest Acute Care Hospital

In the second model, we examined associations between the tract-level driving times to the second nearest acute care hospital in 2018 and tract, county, and state characteristics (objective 3; Table 5). Consistent with the descriptive findings (Table 2), tracts with moderate and high shares of Black residents had longer travel times (moderate: $\beta = 1.135$, 95% CI: 0.121-2.149; high: $\beta = 2.039$, 95% CI: 0.371-3.707; $P = 0.017$) relative to tracts with a low share, even after accounting for other factors in the model. The share of Latinx residents in the tract was not significantly associated with travel time. The top quintile for median household income was also associated with longer travel times versus those in the bottom quintile ($\beta = 1.137$; 95% CI: 0.126-2.149; $P = 0.028$).

The findings also showed that tracts located within nonmetropolitan counties with an urban population of <2,500 and adjacent to a metro area (RUCC 8) had shorter driving times to the second nearest hospital ($\beta = -1.247$; 95% CI: -2.444 to -0.0497; $P = 0.041$) compared with tracts located within nonmetropolitan counties with an urban population of $\geq$20,000 or more adjacent to a metro area (RUCC 4). In contrast with the findings for tract-level travel times to the nearest hospital, we found that county closure status was not associated with travel time to the second nearest hospital.

Table 5. Associations Between Travel Time to Second Nearest Acute Care Hospital and Tract ($n = 2,877$), County ($n = 720$), and State ($n = 13$) Characteristics, 2018[a]

	Characteristic	**β**	95% CI		***P*-Value**
Tract	Latinx share of population				
	Low share (<30%) (ref)	–	–	–	–
	Moderate share (30%-59.9%)	0.423	−0.962	1.809	0.549
	High share (60%-100%)	−0.669	−2.185	0.850	0.388
	Black share of population				
	Low share (<30%) (ref)	–	–	–	–
	Moderate share (30%-59.9%)	1.135	0.121	2.149	0.028*
	High share (60%-100%)	2.039	0.371	3.707	0.017*
	Median household income (2014-2018)				
	20th percentile (ref)	–	–	–	–
	40th percentile	0.725	−0.199	1.650	0.124
	60th percentile	0.442	−0.499	1.382	0.357
	80th percentile	0.915	−0.0542	1.883	0.064
	Top quintile	1.137	0.126	2.149	0.028
	Gini coefficient (2014-2018)	−3.361	−8.462	1.734	0.197

Continued

Table 5. (Continued)

	Characteristic	β	95% CI		P-Value
County	County degree of rurality (RUCC 2013)[b]				
	4 (ref)	–	–	–	–
	5	−0.008	−1.287	1.270	0.990
	6	0.382	−0.406	1.170	0.342
	7	−0.083	−0.981	0.815	0.856
	8	−1.247	−2.444	−0.0497	0.041*
	9	−0.638	−1.881	0.605	0.314
	County closure status 2007–2018				
	≥1 closures (ref)	–	–	–	–
	No closures	0.121	−1.095	1.337	0.845
	Age dependency ratio (2010-2-18)				
	Decreased (ref)	–	–	–	–
	Unchanged	1.168	-5.615	7.951	0.736
	Increased	−0.145	−1.180	0.890	0.784
	Median age (2014-2018)	−0.109	−0.174	−0.044	<0.001*
	Uninsured rate, ages 18–64—county (2014-2018)	−0.019	−0.063	0.025	0.394

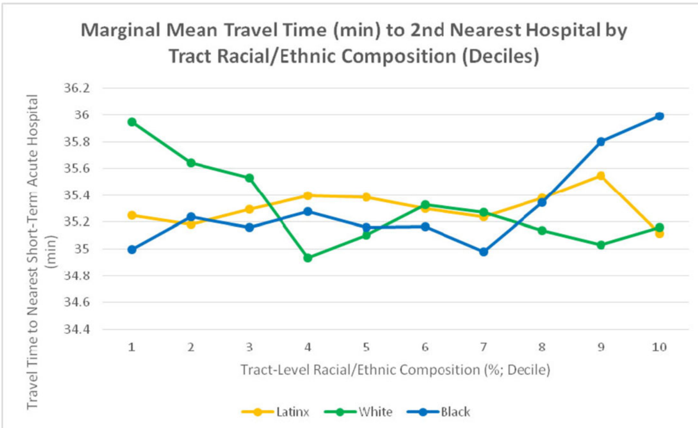
Continued

Table 5. (Continued)

	Characteristic	β	95% CI		*P*-Value
State	Medicaid expansion status (2018)				
	Nonexpansion state (ref)	–	–	–	–
	Expansion state	−0.811	−2.225	0.603	0.261
	Health insurance market concentration—state (2017)	−4.185	−5.951	−2.419	<0.001*

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; CI, confidence interval; RUCCs, Rural-Urban Continuum Codes.
*$P < 0.05$.
[a]Model diagnostics: AIC, 21370.79; BIC, 21502.01.
[b]RUCC 2013 codes for nonmetro counties are as follows.
4: Nonmetro—Urban population of 20,000 or more, adjacent to a metro area.
5: Nonmetro—Urban population of 20,000 or more, not adjacent to a metro area.
6: Nonmetro—Urban population of 2,500 to 19,999, adjacent to a metro area.
7: Nonmetro—Urban population of 2,500 to 19,999, not adjacent to a metro area.
8: Nonmetro—Completely rural or less than 2,500 urban population, adjacent to a metro area.
9: Nonmetro—Completely rural or less than 2,500 urban population, not adjacent to a metro area.

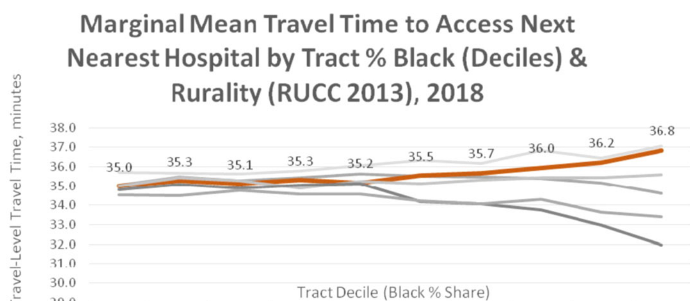
Figure 2. Marginal Mean Travel Time (Minutes) to Second Nearest Short-Term Acute Hospital by Tract Racial/Ethnic Composition (Deciles), 2018.



We also found a negative association between travel time and the state-level concentration of health insurance markets ($\beta = -4.185$; 95% CI: -5.951 to 2.419; $P < 0.001$). Put another way, rural tracts within Southern states with more highly concentrated commercial health insurance markets had shorter travel times to access the second nearest acute care hospital.

In Figure 2, the predicted mean travel times by tract-level racial and ethnic composition are shown by decile. Generally, distance to the nearest alternative hospital increases as the share of Black residents increases, whereas the converse is true for the tract share of White residents. Moreover, when we examined the cross-level interaction terms by tract Latinx population share and county RUCC level, we found that there are no significant main effects and interaction terms are not significant. Conversely, when we tested the cross-level interactions terms for tract Black population share and county RUCC level, we found that tracts with higher shares of Black residents nested within RUCC 6 ("Nonmetro—Urban population of 2,500 to 19,999, adjacent to a metro area") counties had significantly longer travel times to the second nearest hospital

Figure 3. Plot of the Marginal Mean Travel Time to Access the Second Nearest Hospital by Tract % Black (Decile) and Rurality (RUCC 2013), 2018.



	1	2	3	4	5	6	7	8	9	10
RUCC 4	35.0	35.5	35.3	35.4	35.6	35.5	35.5	35.4	35.2	34.6
RUCC 5	35.7	35.7	35.6	35.8	36.1	36.3	36.2	36.8	36.4	37.1
RUCC 6	35.0	35.3	35.1	35.3	35.2	35.5	35.7	36.0	36.2	36.8
RUCC 7	35.0	35.4	35.3	34.9	35.2	35.1	35.3	35.4	35.4	35.6
RUCC 8	34.8	35.1	34.9	35.0	35.1	34.2	34.1	33.8	33.0	32.0
RUCC 9	34.5	34.5	34.8	34.6	34.6	34.2	34.1	34.3	33.6	33.4

Abbreviation: RUCC, Rural-Urban Continuum Code.

($\beta = 0.0370$; $P = 0.003$; 95% CI: 0.012-0.062; Appendix,Table A2). Thus, the tract share of Black residents modifies the association between rurality and travel time to the second nearest hospital in RUCC 6 counties (Figure 3). Moreover, because these rural tracts neighbor metro areas, the second nearest hospitals are likely to be urban hospitals.

Discussion

Policymakers and media outlets have raised concerns in recent years over the acceleration of hospital closures in rural areas. Our results indicate that the US South experienced a substantial loss of hospitals from 2007 to 2018, but the resultant spatial accessibility to hospitals varied by area-level social, demographic, and rurality characteristics. Overall, more than 6 million residents in the rural South experienced worsened access to the nearest acute hospital between 2007 and 2018.

We found that the county supply of short-term acute care hospitals declined across the rural US South to a greater degree than prior reporting, when accounting for facility losses due to closures, mergers, and conversions (objective 1). When measured by county, our estimates of the number of counties that lost a hospital—or all hospitals—exceed prior estimates. In addition, the loss of rural hospitals was associated with increases in average travel distances and travel times to the nearest acute hospital between 2007 and 2018. However, the net impact of these closures was mixed: some tracts had worsened spatial access, whereas others had unchanged or improved access. This may help to explain why some prior studies have found worsening access to care after rural hospital closures and others have not.[85,86]

We extended existing work on rural hospital closures by analyzing distance and travel time to the second nearest hospital. For rural residents for whom the range and availability of acute care services is often limited, the second nearest hospital provides an important option that expands available care opportunities. Limited spatial access to the second nearest facility thus can restrict hospital availability and choice for rural residents. Our results show that in 2018, residents of many census tracts in the rural South faced long travel distances and times to the second nearest facility, with an average distance of more than 35 miles and average estimated travel time of >26 minutes. These indicators increased by >20% from 2007 to 2018 as hospital closures reduced spatial access for those living in the rural South.

With respect to demographic and socioeconomic characteristics, we found that, in 2018, residents in tracts that experienced worsened spatial access to acute hospitals since 2007 had longer mean travel times and travel distances to access their nearest hospital compared with tracts with improved or unchanged spatial access (15.6 minutes for tracts with worsened access versus 7.7 minutes for tracts with improved access and 7.9 minutes for tracts with unchanged access; Table 3). We also found that tracts with worsened spatial access had lower incomes on average than other tracts and that the most rural tracts (RUCC 9) were more likely than others to experience worsened spatial access; however, these disparities were relatively small. Overall, the findings indicate that the impacts of changes in acute hospital supply on travel time have occurred in diverse social and geographical contexts in the rural South. In short, the overall impact of the large number of hospital closures in the US South does not translate to a straightforward association with worsened spatial access to care—which is consistent with other studies that have found mixed effects on hospital utilization postclosure.[85]

Consistent with prior research,[87] we found that rural tracts in states that expanded Medicaid by January 2018 were less likely to experience worsening access between 2007 and 2018, whereas those in nonexpansion states were more likely to experience worsening access. This timeframe parallels earlier work that found the impacts of Medicaid expansion on access to care were most apparent six or more years postexpansion.[88]

The changes in spatial access set the context for the travel time inequities present in 2018 (objective 2). Our second contribution is to show how these disparities in spatial access vary across census tracts in the rural South, with a particular focus on vulnerable populations. First, we found that residents in rural tracts within closure counties had comparatively shorter driving times to the nearest hospital (20.6 minutes versus 22.3 minutes in nonclosure counties; $P = 0.0154$), reflecting their disproportionate location within rural counties adjacent to metro areas (RUCCs 4, 6, and 8), consistent with prior work showing that rural hospital closures were clustered in more populous counties adjacent to metro counties after 2010 and reversing the prior trend of closures disproportionately occurring in more remote rural places.[64] Then, we found that tracts with high shares of Latinx residents had longer travel distances and times to both the first and second nearest acute hospital compared with high share White rural tracts. These findings are consistent with prior studies that have identified increased travel time for rural and nonrural Hispanic communities, both cross-sectionally and after hospital closures.[64,89,90] The findings of our multilevel models—in which these associations are not statistically significant—suggest potential pathways for the observed inequities in Latinx community spatial access to care. Namely, Latinx spatial access to care may be driven by structural spatial inequities in income and insurance markets. At the nexus of racism and xenophobia, rural Latinx communities are most often constrained to low-income, agricultural occupations, with limited access to employer-sponsored private coverage and immigration restrictions on public insurance.[91] Revenue-based hospital location decisions are thus incentivized away from rural Latinx communities.

In contrast, we found that high Black share tracts did not experience longer travel times or distances to the nearest hospital but to the second nearest hospital. Spatial accessibility to the nearest hospital may be shorter for Black rural residents because of their residential patterning in more metro-adjacent areas. Within this sample, rural tracts with a high share of Black residents were generally less populous than those with a high share of White or Latinx residents but also located in counties with RUCC classification <8, i.e., lower rurality (authors' analysis of ACS five-year estimates, 2014–2018 data). In other words, high Black share rural tracts may have shorter mean travel times and distances to the nearest hospital because of lower rurality. High White share tracts include those at the highest levels of rurality; thus, mean times and distances reflect the broader geographic spread of rural White populations. Also, our findings may appear to conflict with prior work that identified hospitals in service areas with more Black and Hispanic residents are at greater risk of closure,[45] especially since 1990.[64] However, we note that our study addresses spatial access at the tract level, whereas observed associations with an aggregate, county-level share of Black residents may better reflect structural racism processes (racialized inequities in income, community disinvestment) that predispose a hospital to closure.

Fundamental structural racism that operates at larger area levels may explain why we found high share Black tracts faced longer distances to the second nearest facility, even when accounting for multiple demographic and policy factors. Travel time increases significantly as the tract share of Black population expands (Figure 3 and Table 4; see also Appendix, Figure A1) (objective 3). Black communities might have spatial accessibility to the nearest hospital by virtue of proximity to hospitals serving urbanized (including White) populations, but their broader context of hospital accessibility may be contingent on access to other rural hospitals—particularly communities farther from metro areas. Many rural Black communities in the South were already the least served by hospitals in the wake of the construction of segregated hospitals with Hill-Burton funds,[92] Medicare implementation,[93] and hospital desegregation (including the subsequent wave of closures of Black hospitals).[94] If rural hospitals in high share Black counties have increasingly closed over time, then the second nearest hospital may be another urban hospital. The racialization of spatial access would lead to our observed interactions between share of Black residents and RUCC level 6 (Figure 3).

Our multilevel models (objective 3) also provided insight on other population and structural factors related to spatial access to care in 2018. Rural tracts with higher median household income had greater travel times to the second nearest hospital. At the state level, higher concentration of health insurance markets was inversely associated with travel time to the second nearest acute hospital, which may indicate greater dispersion of hospitals within rural areas in states where insurance markets are more concentrated. States with lower levels of insurance market competition may face lower pricing competition, which partly drives financial precarity among more rural hospitals.[95]

Although the multilevel models did not show statistically significant associations between state-level Medicaid expansion and travel times in 2018, we found that tracts located in states that expanded Medicaid coverage were less likely than those in other states to experience worsened spatial access from 2007 to 2018 (Table 1) and more likely to experience improved access. Given that as of 2018, our data reflect the end result of a period of closures and state expansions, our outcomes are somewhat distant from the events and coincident with more proximal contemporary factors, e.g., area-level incomes. In addition, recent research on critical access hospitals has found Medicaid expansion alone was not sufficient to address the financial and staffing concerns of these rural safety net providers.[96]

Irrespective of estimated magnitude, our paper highlights inequities that should not exist. Given time as a social determinant of health—to the extent that space-time inequities are prevalent across all manner of health system access—these time burdens accumulate to exacerbate overarching racial health inequities.[22]

Implications

The implications of this study are severalfold. First, we identified greater declines in rural hospital supply in the US South than previously reported, revealing that rural hospital closures must be examined within the context of regional hospital environments—not just closures but also conversions and mergers. Second, by analyzing spatial accessibility of care at the subcounty scale (here, census tracts), we draw attention to the heterogeneous effects of hospital closures within counties and spillover effects on neighboring areas. Rural hospital closures and their resulting effects on spatial access to care potentially have a chilling effect on health service use in rural areas,[97] including longer ambulance trips,[13] more preventable hospitalizations,[11] and increased mortality associated with failure to treat emergent conditions like heart attacks and unintentional injuries in a timely manner.[16,20,98,99] Put another way, the means by which health systems become more efficient (e.g., vertical integration and closure of facilities) may result in increased patient burdens associated with care access[42,100] on top of increased health care prices for patients in their geographic markets.[79,101] For this reason, our study accounted for travel burdens to access an alternative hospital, (i.e., second nearest hospital), not just the nearest.

Our findings on spatial accessibility to second nearest hospitals are particularly relevant in light of high rates of nearest hospital bypass by residents of rural communities.[70] In 2018, rural-dwelling Medicare beneficiaries in the US South had the highest rates of avoidable hospital bypass to urban hospitals compared with beneficiaries in other regions.[102] Emergency Medical Service (EMS) transport services are also more likely to bypass the local hospital in areas where the local availability of emergency departments is low.[103] Prior work has also found that bypass behaviors are influenced by distances to alternative hospitals, whereby bypass rates are inversely associated with the distance to the nearest alternative hospital.[104–106]

Third, our findings advance the literature on rural, racial, and ethnic inequities in spatial access to the spectrum of health care services. To our knowledge, our study is the first to analyze how contemporary rural hospital closures may result in time/travel burdens for rural Black and Latinx communities. For Black and Latinx residents, longer travel distances may contribute to lower health care utilization rates, including for preventive care such as cervical cancer screenings, with adverse health consequences.[65,107] These travel burdens have implications for health care outcomes. This is notable because rural Black and Latinx populations also experience some of the greatest health inequities, including cancer screening and care access and mortality outcomes.[108,109]

Our findings with respect to racial disparities in terms of the spatial accessibility of the second nearest hospital are also important in their attention to Black rural communities because hospital bypass patterns are also racialized. Decreased spatial access to the second nearest hospital may lead to increased delays in emergency care because EMS providers are also more likely to divert Black patients, thereby increasing the time between activation and arrival.[103] Rural Black patients may also experience greater barriers to nonemergency specialty care because Black patients who bypass nearest hospitals for specialty services, such as scheduled surgical procedures, more often receive care from other hospital outpatient departments. Racial inequities in access may continue widen with decline in hospital supply, given the overall trend of increased use of specialists and simultaneous declines in primary care visits among adults in the United States.[110]

Of growing concern is that rural Black and Latinx Americans disproportionately live in underinvested counties, which may in turn increase the risk not only of hospital closure but of secondary deterioration in local health system infrastructure. Rural hospital closures are associated with a decline in physician supply,[55] and rural Black and Latinx communities are already persistently designated primary care health professions shortage areas.[111] The loss of hospitals could thus create a worsening cycle of increasing inequities in mortality, from inadequate primary care management to limited access to specialty care and delays in receipt of emergent care.[17–20,112] The identified racial and ethnic inequities in travel distance and times to hospital-based acute care should also be understood in the context of low wages, limited access to transportation, time scarcity due to long work hours and lack of paid sick leave,[35] and limited mobility due to disability and chronic conditions. Put another way, time as an SDoH means that health disparities (not just access disparities) are being created from time inequities because of spatialized inequities in health system access.

Limitations

Our study has multiple limitations. We elected to measure spatial accessibility rather than utilization or other measures of realized access. Because the focus is on the costs of accessing care for rural residents, we examined population-based travel distances and times to the nearest and second nearest hospital rather than use methods such as the two-step floating catchment area method, which provides an estimate of provider/population ratio.[5] Furthermore, we were unable to conduct a longitudinal analysis of associations between tract-level changes in population composition and age structure and spatial accessibility due to changing census tract boundaries over time. For this reason, our distance measures are based on population-weighted census tract centroids from the end year of the study period. Analyzing changes in spatial access dynamically over time is an important priority for future research. We focused our study on Black and Latinx populations; further study is needed on impacts related to American Indian and other communities of color, who are likely to experience differential impacts because of hospital closures and access to other systems (e.g., Indian Health Services). We also did not investigate the characteristics of nearest and next nearest hospitals such as hospital accreditation, services offered, or quality measures. Such factors, although important, are already conditioned on the multiple structural conditions included in our models, e.g., services offered are largely shaped by relative profitability and area-level socioeconomic conditions. Disentangling these relationships requires more detailed investigation. Lastly, we were unable to assess the impacts of changes in spatial access on health outcomes or access to other types of non–hospital-based health services. Nevertheless, describing spatial access is a necessary first step toward understanding how changes in rural hospital geographic distribution can affect the health of rural populations.

Conclusion

Compared with high share White rural tracts, high share Black and Latinx rural tracts across the US South had poorer spatial access to acute care hospitals in 2018 when driving times to the nearest and second nearest short-term acute care hospital were considered. Gee and colleagues wrote, "Because time is differentially allocated by race, time may account for some of the racial inequities in health. Conversely, this also implies that racial/ethnic minorities potentially have the most to gain by interventions that promote time equity."[22] Thus, this study can be situated in the literature on the joint, cascading effects of the time costs of accessing care. Such costs can alter help-seeking behaviors in ways that increase both health care spending and health care costs to patients.

Amid the COVID-19 pandemic, the disparate impact of hospital closures on Black, Latinx, and rural communities compounds the cumulative disadvantages borne by these groups. In addition to lower health care system capacity, rural counties have lower COVID-19 testing rates per population[113] and lower COVID vaccine uptake[114] compared with urban counties. Moreover, high share Black counties have higher increases in COVID-19 mortality since March 2020.[115] These disparities are exacerbated by the fact that rural communities have fewer jobs that can be done remotely[116] and higher likelihood of having a member who is an "essential worker" among Black households.[117] Furthermore, the design of the relief payouts to hospitals affected by the COVID pandemic under the Coronavirus Aid, Relief, and Economic Security (CARES) Act reinforced preexisting inequities between hospitals that primarily serve White patients and those that serve a majority of Black and Latinx patients.[118]

Our findings point to the importance of federal and state investments to shore up rural health care systems, with specific avenues to support spatial access for rural Latinx and Black communities. First, policies to support rural hospitals include short-term solutions such as Disproportionate Share Hospital payments, state Medicaid expansion, and more equitable distribution of CARES Act funding to rural hospitals that serve low-income communities of color. The Centers for Medicaid and Medicare Services could develop a system similar to the Critical Access Hospital program, based not on travel between facilities but rather filling gaps in spatial access for rural Black and Latinx communities. Given that our findings were also associated with state-level insurance market concentration, network adequacy standards should include spatial accessibility to the second nearest hospital and include explicit racial equity standards as well.

Second, policymakers should invest in spatial access to ambulatory care, both primary and specialty, for rural communities of color. After hospital closure, rural health centers and FQHCs fulfill an important role in providing outpatient care.[119] The methods for designation and investment in these facilities deserve greater attention in light of demographic shifts in rural communities, e.g., accounting for shortages of culturally and linguistically appropriate health services.[120,121] For example, rural communities that have recently become high share Latinx are less likely to have community health centers nearby compared with more established "gateway communities."[122]

We emphasize that the above recommendations reflect short- and medium-term solutions. Given that spatial inequities in access to care arise from underlying racialized structural processes that produce spatial inequities in wealth and income (to name a few), long-term solutions include reparations owed to Black communities and removal of racialized immigration restrictions to Latinx communities in opportunities for health insurance, occupations, and income.

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Appendix

Table A1. Count of Census Tracts with Travel Distances to Acute Care That Exceed 30, 45, and 60 Minutes, 2018

	Nearest Hospital		Second Nearest Hospital	
Network Travel Distance	Number of Tracts (%)	Population (2014-2018)	Number of Tracts (%)	Population (2014-2018)
≥30 minutes	699 (16.3%)	2,875,196 (16.3%)	3,088 (71.9%)	12,691,132 (71.9%)
≥45 minutes	36 (0.8%)	163,905 (1.0%)	868 (20.2%)	3,528,570 (20.0%)
≥60 minutes	4 (0.1%)	16,858 (0.1%)	59 (1.4%)	247,224 (1.4%)

Table A2. Associations Between Travel Time to Second Nearest Acute Care Hospital and Tract ($n = 2,877$), County ($n = 720$), and State ($n = 13$) Characteristics (2018) With Interaction Term Added

	Characteristics	**β**	95% CI		***P*-Value**
Tract	Black percent × RUCC 2013				
	4	0.0003642	−0.0326845	0.033413	0.983
	5	0.0281541	-0.0253357	0.0816438	0.302
	6	0.0370749	0.0121976	0.0619523	0.003*
	7	0.0155005	−0.0191043	0.0501052	0.380
	8	−0.0323616	−0.0802008	0.0154776	0.185
	9	−0.00949	-0.0572615	0.0382815	0.697
	Latinx share of population				
	Low share (<30%) (ref)	–	–	–	–
	Moderate share (30%-59.9%)	0.1061671	−1.699949	1.912284	0.908
	High share (60%-100%)	−1.122112	−3.087241	0.8430183	0.263
	Median household income (2014-2018)				
	20th percentile (ref)	–	–	–	–
	40th percentile	0.6113676	−0.5783223	1.801058	0.314
	60th percentile	0.2269528	−0.9862891	1.440195	0.714
	80th percentile	0.6363256	−0.6193719	1.892023	0.321
	Top quintile	1.111907	−0.2102974	2.434111	0.099
	Gini coefficient (2014-2018)	1.22674	−4.598097	7.051566	0.680

Continued

Table A2. (Continued)

	Characteristics	**β**	95% CI		***P*-Value**
County	County closure status 2007–2018				
	≥1 closures (ref)	–	–	–	–
	No closures	−0.0067409	−1.535953	1.522472	0.993
	Age dependency ratio (2010-2018)				
	Decreased (ref)	–	–	–	–
	Unchanged	2.005983	−6.832962	10.84493	0.656
	Increased	−0.0797377	−1.415499	1.256023	0.907
	Median age (2014-2018)	−0.1478007	−0.2292362	−0.0663652	<0.001*
	Uninsured rate, ages 18–64—county (2014-2018)	−0.0122935	−0.0700611	0.0454741	0.677
State	Medicaid expansion status (2018)				
	Nonexpansion state	–	–	–	–
	Expansion state	−1.241604	−3.040293	0.5570858	0.176
	Health insurance market concentration—state (2017)	−4.839296	−7.140863	−2.537728	<0.001*

Abbreviation: RUCC, Rural-Urban Continuum Code.
*$P < 0.05$.

Figure A1. Chart Showing the Median Additional Travel Time (Minutes) to Access Nearest Alternative Acute Hospital in 2018 by Racial and Ethnic Composition