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Do New Trauma Centers Provide Needed or Redundant Access?

A Nationwide Analysis

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Social Media:

We used a geographical approach to examine access to trauma care in the US in 2014 and 2019. New trauma centers, especially Level 1&2, were usually opened in locations with existing access. Largely, Level 3, 4, and 5 centers have helped expand access to underserved populations. @A_FerreAleman; @ClaridgeJeffrey; @esthertsengmd; @laurarbrownmd; @vanessapho; @metrohealthCLE

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Abstract

Background: Our prior research has demonstrated that increasing the number of trauma centers (TCs) in a state does not reliably improve state-level injury-related mortality. We hypothesized that many new TCs would serve populations already served by existing TCs, rather than in areas without ready TC access. We also hypothesized that new TCs would also be less likely to serve economically disadvantaged populations.

Methods: All state-designated adult TCs registered with the American Trauma Society in 2014 and 2019 were mapped using ArcGIS Pro. TCs were grouped as Level 1-2 (Lev12) or level 3-5 (Lev345). We also obtained census tract-level data (73,666 tracts), including population counts and % of population below the federal poverty threshold. Thirty-minute drive-time areas were created around each TC. Census tracts were considered "served" if their geographic centers were located within a 30-minute drive-time area to any TC. Data were analyzed at the census tract-level.

Results: 2140 TCs were identified in 2019, with 256 new TCs and 151 TC closures. 82% of new TC were Level 3-5. Nationwide, coverage increased from 75.3% of tracts served in 2014 to 78.1% in 2019, representing an increased coverage from 76.0% to 79.4% of the population. New TC served 17,532 tracts, of which 87.3% were already served. New Lev12 TCs served 9,100 tracts, of which 91.2% were already served; New Lev345 TCs served 15,728 tracts, of which 85.9% were already served. Of 2,204 newly served tracts, those served by Lev345 TCs had higher mean % poverty compared with those served by Lev12 TCs (15.7% vs 13.2% poverty, $p<0.05$).

Discussion:

Overall, access to trauma care has been improving in the United States. However, the majority of new TCs opened in locations with pre-existing access to trauma care. Nationwide, Level 3, 4, and 5 TCs have been responsible for expanding access to underserved populations.

Level of Evidence: Epidemiological, Level III

Keywords: Trauma center; Access; Disparities; Trauma Systems

Introduction

Traumatic injury is one of the leading causes of death among adults in the United States and responsible for 20% of all life years lost before the age of 85.[1, 2] The systems approach to trauma care is widely accepted as an effective strategy for reducing trauma mortality and improving patient outcomes.[3-6] Trauma centers (TCs) offer specialized care and expertise for the traumatically injured patient. Resources available at TCs include trauma surgeons, interventional radiologists, surgical subspecialists such as orthopedic and neurological surgeons, and immediate availability of operating rooms.[2] Organized trauma systems, including prehospital triage criteria and transport frameworks, have been shown to significantly decrease mortality for trauma patients.[2, 4, 5, 7]

Despite the documented benefits of accessible TCs, not all areas of the country have equal access to these centers. While 84% of Americans live within 1 hour of a TC, rural areas remain underserved.[2, 6] Longer prehospital transport times likely contribute to the higher mortality rates seen among rural trauma patients when compared to their urban counterparts.[2, 8, 9] Similarly, TC density and distribution can cause relative "trauma deserts," areas without ready access to a trauma center, even within urban areas. These deserts with increased transport times have been shown to adversely affect patient mortality.[2] While the overall number of TCs has increased, previous studies have suggested that their geographic locations vary widely, continuing to leave some areas without timely access to trauma care.[6, 10, 11] Conversely, some locations may have too many trauma centers, possibly leading to inefficiencies, lower patient volumes per center, resource waste, and reduced quality of care.[6, 7, 12-14] While there is robust literature detailing the adverse patient outcomes associated with areas lacking expedient access to trauma centers, there is a substantial

gap in our understanding of how trauma center openings and closures over time affect population access to trauma care.

Our prior research has suggested that simply increasing the number of trauma centers in a state does not have a measurable effect on trauma-related deaths, suggesting that new trauma centers may not be optimally located to affect injury mortality.[10] Multiple studies have prompted concern that numerous level 1 and 2 trauma centers serving the same geographic location can lead to oversaturation of some areas while lower level TCs are providing care in underserved areas.[1, 8, 15, 16] If new trauma centers are added in saturated markets which serve wealthier populations and close in poorer communities, this is a concerning trend that would widen disparities in access to trauma care. We hypothesized that new trauma centers would serve populations already served by existing trauma centers, rather than in "trauma deserts." We also hypothesized that new trauma centers would be less likely to serve geographic areas with high racial and ethnic minority populations or high poverty rates.

Methods

For this study, we utilized data at two time points: 2014 and 2019. We combined data from the American Trauma Society Trauma Information Exchange Program from 2014 and 2019 with public data at the census-tract level from the United States Centers for Disease Control and the University of Minnesota's Integrated Public Use MicroData Set (IPUMS) National Historical Geographic Information Systems (NHGIS) data finder. IPUMS provides census and survey data from around the world integrated across time and space (further information is available at www.ipums.org), and the NHGIS project provides free online summary statistics and GIS files for

US census data and other national data from 1790 through the present (further information from www.nhgis.org). If data were not available from the specific year of interest, this is noted and data as close to the year of interest was obtained.

Trauma Center Data

All trauma centers registered with the American Trauma Society Trauma Improvement Exchange Program (TIEP) as Adult Trauma Centers of any level designation were included. State designation level was preferentially utilized; if not available, the American College of Surgeons verification level was utilized. If neither were available, the hospital was not included. Trauma center levels were classified as levels 1, 2, 3, 4, or 5; for the purposes of analysis, trauma centers were grouped as Level 1 or 2 (Lev12) or levels 3 through 5 (Lev345). All trauma centers were mapped by their address as listed in the TIEP database using ArcGIS Pro software. All 2014 hospitals within 0.5km of but not perfectly overlapping a 2019 center was manually checked and adjudicated using the public record. Hospitals that changed names or changed addresses with the same American Hospital Association (AHA) number registered were considered the same trauma center. In addition, a visual inspection of the map for each state was performed to identify whether centers near each other were in fact, the same trauma center (to identify instances, for example, where an address had changed and was more than 0.5km away from the original address). Any closely related trauma centers or trauma centers with hospital name changes were manually adjudicated using public records.

Data at the Census Tract Level

Public maps and GIS data which were obtained include census tract-level data on total population and total population by race/ethnicity, and the ratio of income to poverty level taken from the American Community Survey (ACS). Specifically, data from the ACS 5-year estimate period of 2010-2014 was utilized for 2014 and period of 2015-2019 was utilized for the 2019 time point.

Total population estimates were utilized for 2014 and 2019. Race and ethnicity data from the NHGIS provided race and ethnicity combinations: data were divided first into ethnicity groups as Hispanic or Latino and not Hispanic or Latino; within non-Hispanic groups, we utilized the following race categories: White, Black/African American, Asian, American Indian, Pacific Islander, and Other race. There was a small amount of missing data within the data provided accounting for <2.5% of the population.

Poverty level was provided for each census tract level as % of individuals within a census tract who met the federal poverty level, calculated using the total number of individuals for whom poverty level was documented in the American Community Survey. The poverty index was also utilized, which is a ratio of actual income divided by the federal poverty level (for example, if a household income is twice the federal poverty level, the poverty level index would be 2.0). The federal poverty level is calculated yearly and set by the federal government; in 2014, the federal poverty level was $11,670 for an individual and $23,850 for a family of four, while in 2019, the federal poverty level was $12,490 for an individual and $25,750 for a family of four.[17]

As another measure of social status, we also used the Gini Index, as defined by the United States Census Bureau.[18] The Gini Index is a summary measure of income inequality, which summarizes the dispersion of income across the income distribution. The Gini coefficient ranges from 0 (indicating perfect equality) to 1 (where only one recipient or group of recipient receives all the income).

Trauma Access via Drive Time

We utilized a 30-minute drive time to a trauma center as the threshold to determine if a geographic area was "Served," assuming that with time for EMS response, field assessment, and transport, a patient would reasonably arrive to a trauma center within the "golden hour." We mapped 30-minute drive times to each trauma center using ArcGIS Pro analytic tools, and created a "service polygon" around each trauma center. Service polygons were overlapped on census tracts using ArcGIS Pro. If a service polygon overlapped the middle of a census tract, the tract was considered "served" by that trauma center. Census tracts were categorized as "Served in 2014" and "Served in 2019" and how many trauma centers served that tract at each level. Change in service level was calculated for each census tract such that tracts were characterized into groups: always served, lost service (served in 2014 only), newly served (served in 2019 only), and never served. We also analyzed census tracts examining access by trauma center level (Level 1 or 2 centers and Level 3, 4, or 5).

Analysis

Geographic and census data, as well as maps were merged and created within ArcGIS Pro, and quantitative analysis was performed using STATA 17.0 MP. We report descriptive analysis of

overall national trauma center trends, as well as coverage of tracts and percent of population served. Quantitative analysis was performed at the census tract level. For comparisons over service level groups, population race and ethnicity statistics, and poverty statistics from 2019 were utilized. This study was determined to be not Human Subjects Research by our hospital's Institutional Review Board. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cohort studies was utilized and is included (Supplement, http://links.lww.com/TA/C597).[19]

Results

There were 2140 trauma centers in 2019 registered with the Trauma Information Exchange Program without missing designation or verification level data, with 256 new centers. Of trauma centers which had been present in 2014, 151 were no longer present in 2019. There were 53 centers which did not meet inclusion criteria, had missing data, or could not be mapped in 2014 and 63 (2.9%) in 2019. 82% of new centers were designated Level 3-5. There were 73,666 total census tracts in the United States, of which 55,184 (74.9%) were always served, 15,855 (21.9%) were never served, 289 (0.4%) lost service, and 2,338 (3.2%) were newly served. Nationwide, access to trauma centers increased from 75.3% of tracts served in 2014 to 78.1% in 2019, representing an increased coverage from 76.0% to 79.4% of the population.

Census Tracts and Trauma Center Access in the United States

A map representing the United States is presented in Figure 1, which highlights newly served census tracts, as well as highlights new trauma centers which were placed in census tracts which were already served. Dark gray indicates that a tract was "Always Served," and light gray indicates

a tract was "Never Served." Yellow tracts lost access in the study period and blue tracts gained access during the study period. Green dots show new trauma centers which opened in already served tracts (centers opened in newly served tracts do not need additional visualization as they are represented in blue tracts). Visual inspection of this map verifies that there is a large proportion of trauma centers which are opened in areas of the country which are already served. visual inspection of the map suggests that some states, such as Indiana, have increased trauma access with new centers strategically located in areas which were not previously served. Michigan increased trauma centers throughout the state in previously served and unserved locations. In contrast, the map shows that in Texas, many tracts lost access to trauma centers, juxtaposed by multiple new trauma centers in already served locations.

Population Demographics and Access to Trauma Centers

Using population estimates from 2019, approximately 60% of the population was non-Hispanic white, 18.8% of the population was Hispanic, and 12.2% of the population was non-Hispanic Black (Table 1). Visual inspection of the map shows that trauma centers tend to be located in urban centers. Additionally, newly served census tracts tended to be in areas other than urban centers (suburban or rural areas). In 2014, patients of black, Hispanic, and Asian racial and ethnic minorities were well-served with local access to trauma centers. Examining the underlying factors for this, individuals of non-white race and ethnicity tended be concentrated within specific census tracts which were located near urban centers which were well-served by trauma centers. Census tracts which were never served tended to have higher percentages of non-Hispanic white residents.

Examining our poverty measures, census tracts which were "always served" tended to have lower poverty. The median poverty level for a census tract which was "always served" was 11.0%, with an interquartile range of 5.9 to 20.0, compared with a census tract which was "never served (13.1%, IQR 7.8, 21.0). Census tracts which lost access also tended to have higher levels of poverty (13.3%, IQR 9.4, 18.9). Newly served census tracts tended to have lower poverty (11.9, IQR 6.9, 19.2] than tracts which lost access. The Gini index mirrored this pattern (Table 2).

New Trauma Centers

New trauma centers served 17,532 census tracts, of which 87.3% were already served. New Level 1 and 2 trauma centers served 9,100 tracts, of which 91.2% were already served. New Level 3-5 trauma centers served 15,728 tracts, of which 85.9% were already served. Of 2,204 newly served tracts, those served by Lev345 trauma centers had higher mean % poverty compared with those served by Lev12 trauma centers (15.7% vs 13.2% poverty, $p<0.05$).

Discussion

Despite an overall increasing number of trauma centers within the United States, there is still a wide variation in access to timely trauma care. Our study reveals that some areas remain largely unserved while others are served by multiple institutions. We found 87.3% of tracts served by new trauma centers already had existing access. New Level 1 and 2 trauma centers served 9,100 tracts, of which 91.2% were already served; new Level 3-5 centers served 15,728 tracts, of which 85.9% were already served. Of 2,204 newly served tracts, those served by Level 3-5 centers had higher mean % poverty compared with those served by Level 1-2 centers (15.7% vs 13.2% poverty, $p<0.05$). The findings of our study mirror those in recent literature. Branas et al. revealed that 46.7

million Americans have no access to a level I or II trauma center within an hour while 42.8 million Americans have access to 20 or more level I or II trauma centers within an hour.[6] Additional studies have shown that close proximity to trauma centers is associated with lower injury related mortality rates in the adult population.[1, 8, 16]

Creation of a trauma system that provides equitable and high-quality access can seem like a "goldilocks" problem. Too few centers in an area creates a trauma desert, but too many centers can also have disadvantages. Prior analysis by Brown et al. suggested that states which cluster trauma centers to provide access to counties with higher population densities have lower injury-related mortality.[20] However, it is unknown whether there is a tipping point, where access tips into oversaturation and loss of efficiency. Maintaining designation as a trauma center requires dedication and resources, and often requiring verification by the American College of Surgeons (ACS) per the standards set forth by the Resources for the Optimal Care of the Injured Trauma Patient.[21] Regional variations exist and not all states require verifications for designation.[22] The cost to sustain a single level I trauma center is estimated to be $6.8 to over $10 million per year, regardless of patient volume.[23, 24] This resource expenditure is duplicated for each successive trauma center opening within the same catchment area. Introduction of new centers within an established center's catchment area can also potentially destabilize patient volume and lead to resource misallocation to unused personnel, operating time, space, and other resources. As there is a strong relationship between trauma center volume and outcomes, dilution of patients to multiple centers may be detrimental to care.[25, 26] It has never been shown that increasing the number of trauma centers in a geographical area which already has access to trauma care improves

patient outcomes or injury-related mortality; our prior research suggested that simply increasing the number of trauma centers in a state has minimal effect on injury-related outcomes.[10]

Despite the challenging expense for hospitals to obtain and maintain trauma readiness, our data suggests that trauma centers increased in number by nearly fourteen percent between 2014 and 2019. However, this dramatic increase in trauma centers did not dramatically improve access to trauma centers across the United States. Only 3% of census tracts changed from "not served in 2014" to "served in 2019." Similarly, only approximately 3.4% of the United States population gained coverage. Particularly concerning was that new Level 1 and 2 trauma centers, which are the costliest to maintain, served 9,100 census tracts, of which 91% had prior access to trauma centers. Prior work from our institution showed that states have different methods of trauma center allocation, whereby some states designate large numbers of trauma centers across the state and others have very few centers. We also found that having more trauma centers in a state did not equate to lower injury-related mortality.[10] Our current study shows substantial variation in opening and closing of centers across the country. While we do not postulate whether individual centers opening and closing necessarily improve or worsen the care of the trauma patients in each of these locations, this study combined with our prior work highlights the variation that exists in trauma center designation across the country. must account for not only available hospital services but also the local community need to maximize the investment and provide the highest quality of care.

This movement of trauma center geography also has serious health equity implications. Our analysis shows that disparities may be widening in access to trauma care, particularly for poorer or rural localities. Racial and ethnic minority groups concentrated in cities such as Black and

Hispanic individuals have local trauma center access, but Native American populations have lost access to trauma care. Additionally, we found the poverty level to be higher in the tracts that lost access and lower in those that gained access, 13.3% vs 11.9%. Similarly, the "never served" tracts exhibit a higher poverty level at 13.1%, than 'always served" tracts at 11.0%. These findings potentially indicate that the most vulnerable populations are losing their only options for trauma care while wealthier populations are gaining additional choices as new centers emerge in already served areas. At its core, trauma care should provide care without prejudice, expediently without consideration of race, ethnicity or socioeconomic status. The trend of increasing trauma centers in wealthy areas of the nation combined with persistent scarcity or loss in less advantaged areas threatens the goal of zero preventable deaths in trauma care. Examining the effects of trauma center density can help the medical community begin to address disparities in care to propel forward the goal of equal, high quality trauma care for all.

Our paper has several limitations. Our data is based on population estimates utilizing census data, which is subject to error inherent in the sample data and may not fully represent the population of the United States. Additionally, we examined two singular points in time, 2014 and 2019, and therefore extrapolation of our data should be done with caution. Our definition of access to a trauma center examined drive times; air medical transport can drastically lower travel time to trauma centers but are not always available due to local community resources and weather limitations. Some communities in America are geographically distant such that a 30-minute drive time to a hospital for every home in America is not feasible. Even so, some states improve access by distributing Level 3, 4, and 5 trauma centers across the state, while others utilize very few centers. It is unclear whether there is a way to purposefully and systematically distribute trauma

care to provide effective and optimal access to all populations. Despite the limitations of our study, we believe our study captures important and relevant trends in trauma center density which merit additional investigation.

Conclusions

Overall, access to trauma care has been improving in the United States. However, the number of new trauma centers outpaces the increases in access, as the vast majority of new trauma centers are opened in locations with pre-existing access to trauma care. Nationwide, Level 3, 4, and 5 trauma centers have been responsible for expanding access to underserved populations. Although it remains uncertain at what point trauma center oversaturation has a detrimental effect on patient care, considering overall geographic need of communities when opening or designating trauma centers may help to ensure that trauma patients are treated equitably and with the highest quality of care.

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Figure 1. Trauma Center Access by Census Tract, 2014 and 2019

Figure 1

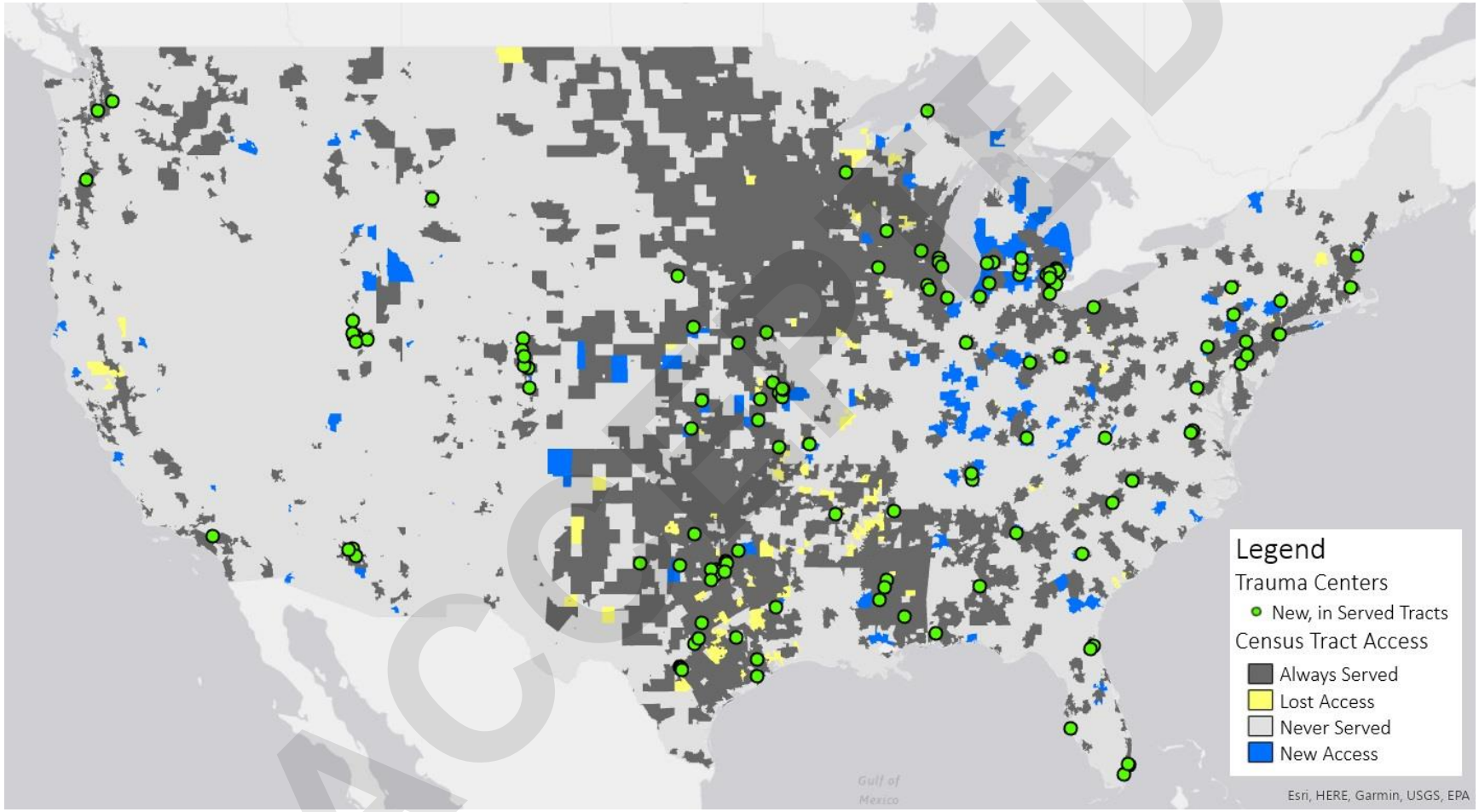

Table 1. United States Population: Race and Ethnicity Distribution by Census Tract Service Type

	Total	Census Tract Always Served	Census Tract Lost Service	Census Tract Newly Served	Census Tract Never Served
Number of Census Tracts[+]	73,666	55,184 (74.9%)	289 (0.4%)	2,338 (3.2%)	15,855 (21.9%)
2019 Population*	328.02	249.50	1.24	10.87	66.41
Hispanic	61.76 (18.83%)	50.23 (20.13%)	0.17 (13.83%)	1.57 (14.45%)	9.79 (14.74%)
White, Non-Hispanic	197.13 (60.10%)	141.39 (56.67%)	0.89 (71.61%)	7.63 (70.17%)	47.23 (71.12%)
Black	39.98 (12.19%)	33.19 (13.30%)	0.12 (9.37%)	0.95 (8.72%)	5.73 (8.63%)
American Indian	2.16 (0.66%)	1.24 (0.50%)	0.01 (1.19%)	0.05 (0.47%)	0.86 (1.29%)
Asian	17.71 (5.40%)	16.09 (6.45%)	0.02 (1.64%)	0.38 (3.50%)	1.22 (1.83%)
Pacific Islander	0.64 (0.20%)	0.52 (0.21%)	0.00 (0.10%)	0.01 (0.08%)	0.11 (0.17%)
Other	0.79 (0.24%)	0.66 (0.27%)	0.00 (0.10%)	0.02 (0.18%)	0.11 (0.16%)

[+]This row shows the total number of census tracts in each group

*All population rows indicate the population, presented in millions (%); the % do not add to 100% due to small amounts of missing data.

Table 2. Race, Ethnicity, Poverty Level, and Gini Index By Census Tract

Category	Median [IQR] all tracts	Census Tract Type*			
		Always Served	Lost Service	Newly Served	Never Served
Race/Ethnicity					
% Hispanic	7.8 [2.8, 21.8]	+1.6 [-4.3, +17.0]	-2.6 [-5.8, +17.0]	-2.1 [-5.1, +7.2]	-3.8 [-6.4, +3.9]
% White Non-Hispanic	69.1 [37.1, 87.0]	-5.0 [-37.6, +13.9]	+11.7 [-10.4, -23.1]	+12.7 [-12.1, +23.7]	+15.7 [-9.3, +24.8]
% Black Non-Hispanic	3.9 [0.8, 14.8]	+1.1 [-2.7, +13.1]	-2.3 [-3.6, +4.8]	-1.4 [-3.3, +5.3]	-2.6 [-3.8, +3.9]
% American Indian	0 [0, 0.4]	0 [0, +0.3]	+0.1 [0, +0.8]	0 [0, +0.4]	0 [0, +0.5]
% Asian	1.5 [0.2, 5.2]	+0.8 [-1.1 , +5.2]	-1.1 [-1.5, 0]	-0.7 [-1.5, +1.1]	-1.5 [-1.2, -0.1]
Poverty Level, % +	11.6 [6.3, 20.2]	-0.6 [-5.7, +8.4]	+1.7 [-2.2, +7.3]	+0.3 [-4.7, +7.6]	+1.5 [-3.8, +9.4]
Gini Index	0.42 [0.38, 0.46]	0 [-0.04, +0.04]	+0.01 [-0.02, +0.04]	-0.01 [-0.04, 0.03]	+0.01 [-0.03, +0.05]

*P-value for differences across groups for all rows is 0.0001

Data are displayed for the census tract groups as normalized to the median value for each row. For example, in the row for % Hispanic, in the Census Tract columns, are numbers are referenced to the value of 7.8% Hispanic (ie the % Hispanic in "Always Served" census tracts is 7.8+1.6 (9.5) and the IQR range is [7.8-4.3, 7.8+17.0] or [3.5, 24.8].

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Title
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3-4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2-6
Bias	9	Describe any efforts to address potential sources of bias	2-6
Study size	10	Explain how the study size was arrived at	3-4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-6
		(*b*) Describe any methods used to examine subgroups and interactions	5-6
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	6
		(c) Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	Report numbers of outcome events or summary measures over time	6-8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-8
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	6-8
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11-12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Title

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

Do New Trauma Centers Provide Needed or Redundant Access? A Nationwide Analysis

National Analysis, at the Census Tract Level

Trauma Centers (TC), 2014 vs. 2019

Tract = Served if within 30-minute drive of TC

Results:

- 87% of New TCs in 2019 in Already Served Tracts
- 91% of Level 1-2 TCs in Already Served Tracts

Conclusions:

Local needs must be considered when allocating TC resources

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