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Community Socioeconomic and Urban–Rural Disparities in Prehospital Notification of Stroke by Emergency Medical Services in North Carolina

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Abstract

Objectives: Notification by emergency medical services (EMS) to the destination hospital of an incoming suspected stroke patient is associated with timelier in-hospital evaluation and treatment. Current data on adherence to this evidence-based best practice are limited, however. We examined the frequency of EMS stroke prenotification in North Carolina by community socioeconomic status (SES) and rurality.

Methods: Using a statewide database of EMS patient care reports, we selected 9-1-1 responses in 2019 with an EMS provider impression of stroke or documented stroke care protocol use. Eligible patients were 18 years old and older with a completed prehospital stroke screen. Incident street addresses were geocoded to North Carolina census tracts and linked to American Community Survey socioeconomic data and urban–rural commuting area codes. High, medium, and low SES tracts were defined by SES index tertiles. Tracts were classified as urban, suburban, and rural. We used multivariable logistic regression to estimate independent associations between tract-level SES and rurality with EMS prenotification, adjusting for patient age, sex, and race/ethnicity; duration of symptoms; incident day of week and time of day; 9-1-1 dispatch complaint; EMS provider primary impression; and prehospital stroke screen interpretation.

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Results: The cohort of 9527 eligible incidents was mostly at least 65 years old (65%), female (55%), and non-Hispanic White (71%). EMS prenotification occurred in 2783 (29%) patients. Prenotification in low SES tracts (27%) occurred less often than in medium (30%) and high (32%) SES tracts. Rural tracts had the lowest frequency (21%) compared with suburban (28%) and urban (31%) tracts. In adjusted analyses, EMS prenotification was less likely in low SES (vs high SES; odds ratio 0.76, 95% confidence interval 0.67–0.88) and rural (vs urban; odds ratio 0.64, 95% confidence interval 0.52–0.77) tracts.

Conclusions: Across a large, diverse population, EMS prenotification occurred in only one-third of suspected stroke patients. Furthermore, low SES and rural tracts were independently associated with a lower likelihood of prehospital notification. These findings suggest the need for education and quality improvement initiatives to increase EMS stroke prenotification, particularly in underserved communities.

Keywords

disparities; emergency medical services; rural; stroke

Stroke is defined as a neurological deficit secondary to an acute injury to the brain.[1] In the United States, 1 in every 19 deaths is caused by stroke.[2] Furthermore, stroke is a leading cause of permanent disability.[3] Stroke also contributes to a significant cost burden on the US healthcare system, with an estimated $53 billion spent on stroke-related care between 2017 and 2018.[4] First identified in the 1940s, the “Stroke Belt” is a multi-state region in the southeastern United States with elevated rates of stroke morbidity and mortality.[5] Limited access to acute stroke care is considered an important contributor to this disproportionate burden, especially in rural and other underserved areas.

Evidence-based acute stroke therapies, such as intravenous thrombolytics and mechanical thrombectomy, are extremely time sensitive, with treatment delays leading to worse outcomes.[6] The use of emergency medical services (EMS) is associated with improved outcomes for stroke patients secondary to more prompt emergency department arrival, neurologic evaluation, brain imaging, and treatment.[7–11] Furthermore, since 2013, the American Heart Association/American Stroke Association guidelines have recommended prenotification of stroke by EMS to the receiving hospital, which allows emergency department and stroke treatment teams to prepare before patient arrival and expedite in-hospital care.[12]

Although numerous studies have shown that prehospital notification of stroke by EMS reduces in-hospital delays and increases treatment rates,[13–16] population-based data on adherence to this evidence-based practice are limited. A recent analysis of national data from a hospital-based stroke quality improvement program observed that 57% of EMS arrivals were prenotified, which did not change from 2014 to 2019.[17] A statewide survey of EMS agencies in North Carolina found that 98% of agencies reported a stroke prenotification policy; however, fewer than half reported communicating prehospital stroke screen results to the receiving hospital, suggesting a disconnect between policy and practice.[18] Although previous research has clearly shown that lower socioeconomic status (SES) and rural

communities have poorer stroke[19] and other health outcomes,[20,21] these disparities in prehospital stroke care, specifically EMS prenotification, are understudied.

The objective of this study was to describe prehospital notification of stroke by EMS in North Carolina, a state in the Stroke Belt, and evaluate differences in this evidence-based practice by community SES and rurality. We hypothesized that stroke patients living in underserved communities of lower socioeconomic and rural status will be less likely to receive prenotification by EMS.

Methods

Study Design and Setting

We performed a retrospective analysis of the North Carolina EMS Data System, a statewide electronic database developed and maintained by the North Carolina Office of EMS. The 100 county-based EMS systems in North Carolina are mandated to submit electronic data on all EMS encounters to this database with the goal of improving EMS system performance and prehospital patient care across the state. Encounter data submitted by EMS systems are standardized based on National EMS Information System version 3. Our study included data on patient demographics (eg, age, sex, race/ethnicity), incident address, EMS response and on-scene care, and incident disposition (see Table S1 for the full list of data elements).

North Carolina is located within the Stroke Belt and ranks eighth highest for stroke mortality in the United States.[22] Furthermore, a large percentage of North Carolina's 10.5 million population lives in rural (43%) areas and below the poverty level (14%).[23,24] Since 2009, the North Carolina Office of EMS has required each EMS system to develop and implement a protocol to direct prehospital care of suspected stroke patients, including stroke screening, triage and transport destinations, and prenotification to the receiving hospital. This study was reviewed by the University of North Carolina at Chapel Hill institutional review board and was approved by expedited review.

Study Population

All of the EMS-suspected stroke encounters occurring in North Carolina in 2019 were considered. A suspected stroke was defined as a 9-1-1 call response by EMS for a patient at least 18 years old in which the EMS provider had a primary or secondary impression of stroke or documented the use of a stroke protocol. Encounters that did not occur within North Carolina or did not result in transport to a hospital were excluded. Eligible patients for this study must have had a documented prehospital stroke scale or screen completed by the EMS provider, indicating an initial suspicion of stroke that led to the management of the patient.

Census Tract Characteristics

We geocoded EMS stroke incident addresses to census tracts using ArcGIS Pro (Esri, Redlands, CA). Census tract data from the American Community Survey 2015–2019 five-year estimates were used to compute a community-level SES index developed by the Agency for Healthcare Research and Quality.[25] This index includes tract-level measures

such as income, wealth, education, occupation, and housing and ranges from 0 to 100, with higher scores indicating higher SES. These scores were divided by tertiles into <51.1, 51.1 to 54.4, and >54.4 representing low, medium, and high SES groups, respectively. Census tract urban–rural commuting area primary codes were grouped to define urban–rural status, with 1 being urban, 2 to 6 being suburban, and 7 to 10 being rural.[26] Figure 1 displays the geographic distribution of SES and rurality by all 2195 North Carolina census tracts.

Patient- and Incident-Level Variables

Patient age was grouped as 18 to 54, 55 to 64, 65 to 74, and ≥75 years. Patient sex was either female or male. Patient race/ethnicity was categorized as White, non-Hispanic; Black, non-Hispanic; non-Hispanic other races, including American Indian or Alaska Native, Asian, and Native Hawaiian or Other Pacific Islander; and Hispanic or Latino. The duration of symptoms was grouped as 0 to 3, 3 to 6, 6 to 24, and >24 hours. The date and time of 9-1-1 dispatch notification to EMS were classified by day of week (weekend or weekday) and time of day (7:00 AM to 2:59 PM, 3:00 to 10:59 PM, or 11:00 PM to 6:59 AM). Incidents with a complaint of stroke reported by 9-1-1 dispatch were identified. The primary impression of the EMS provider was grouped into stroke, altered mental status, weakness, and other categories. Prehospital stroke screen or scale interpretation was documented as positive, negative, or nonconclusive. The outcome of interest was documentation of EMS prenotification of possible stroke to the receiving hospital.

Statistical Analysis

Pearson χ^2 tests were used to assess associations between the frequency of EMS stroke prenotification and census tract SES and urban–rural status, with $P < 0.05$ considered statistically significant. Wald 95% confidence intervals (CIs) also were constructed for the proportion prenotified by levels of census tract characteristics. We estimated odds ratios (ORs) and 95% CIs of prenotification with census tract characteristics using multivariable logistic regression. We first fit a base model with only census tract SES (referent = high SES) and rurality (referent = urban). Then, a fully adjusted model was fit with census tract SES and rurality, adjusting for patient age group, sex, race/ethnicity, duration of symptoms, incident day of week (weekend vs weekday), time of day, stroke complaint reported by 9-1-1 dispatch, EMS provider primary impression, and stroke screen interpretation. Because we expected stroke screen interpretation to influence whether EMS provided prenotification, we ran logistic regression models stratified by positive, nonconclusive, and negative stroke screen and compared ORs by these stratification levels. Statistical analyses were conducted in SAS version 9.4 (SAS Institute, Cary, NC).

Results

We identified a total of 18,251 EMS responses for suspected stroke patients in the 2019 (Figure S1). Among them, 79 were excluded because they either occurred outside of North Carolina or were unable to be geocoded, and 1055 were excluded because the encounter did not lead to EMS transport to a hospital. Of the remaining 17,117 patients who were geocoded and had EMS transport to a hospital, 9527 had stroke scales completed and

recorded, making them eligible for our study. This final dataset represented 1691 of the 2195 total North Carolina census tracts.

Among the 9527 eligible suspected stroke incidents, most occurred in an urban tract (57%) compared with suburban (34%) and rural (9%) tracts. The majority of patients were at least 65 years old (65%), female (55%), and non-Hispanic White (71%) (Table 1). For most EMS responses, the duration of symptoms was <3 hours (71%). Approximately one-fourth occurred on the weekend (26%), and nearly half occurred from 3 to 11 PM (49%). More than half (58%) had a stroke complaint reported by 9-1-1 dispatch, and 86% had a primary impression of stroke from an EMS provider. Prehospital stroke screen interpretation was positive for more than half (58%) of EMS incidents, although substantial proportions were also negative (30%) or nonconclusive (12%).

In the overall study population, suspected stroke was prenotified by EMS in 2783 (29%) incidents. Prenotification varied significantly by tract urban–rural status ($P < 0.001$) and SES ($P = 0.001$) (Fig. 2). Frequencies were greater in urban (31%, 95% CI 30–32) versus rural (21%, 95% CI 18–24) and high SES (32%, 95% CI 30–33) versus low SES (27%, 95% CI 25–28). These differences also were observed in multivariable logistic regression models (Table 2). Similar to estimates from the base model, fully adjusted associations indicated a lower likelihood of EMS stroke prenotification in rural (versus urban) tracts (OR 0.64, 95% CI 0.52–0.77) and in low SES (versus high SES) tracts (OR 0.76, 95% CI 0.67–0.88).

In adjusted models stratified by prehospital stroke screen interpretation (ie, positive, negative, and nonconclusive), associations between EMS stroke prenotification and tract characteristics persisted (Table S2). Similar to those among the overall study population, rural and low SES tracts were less likely to experience EMS prenotification across all of the stroke screen results. The differences were less pronounced when the stroke screen was positive compared with nonconclusive or negative, however.

Discussion

Our statewide analysis found that EMS notification of stroke before hospital arrival occurred less often in rural and low SES communities in North Carolina. Statistical differences in EMS stroke prenotification also were observed after accounting for patient demographics, symptom duration, and several incident characteristics. Overall, the evidence-based practice of prehospital notification by EMS, as recommended in state EMS protocols, occurred in only one-third of suspected stroke patients, indicating room for improvement throughout North Carolina. Moreover, our study highlights relatively low EMS adherence in traditionally underserved rural and low SES communities. These findings suggest that suboptimal prehospital stroke management by EMS may contribute to already well-established disparities in stroke care and patient outcomes by rural and poor socioeconomic environments.[19,27–29]

The overall rate of one-third prenotification by EMS of suspected strokes found in this study is lower than reported in prior studies. Statewide and national estimates of prehospital notification from the Paul Coverdell National Acute Stroke Program, a formal stroke care

quality improvement initiative, range from 49% to 58%.[15–17] These estimates, however, are among patients with a clinical diagnosis of stroke from hospitals and less likely to include transient ischemic attacks and stroke mimics. Whereas true stroke patients are more likely to benefit from EMS prenotification, our broader study population of patients suspected of having a stroke by EMS is relevant for monitoring and improving prehospital stroke care because stroke diagnosis is not known at the time of initial patient management in the field. Although we did not have data on clinical diagnoses, EMS prenotification among true strokes was likely more common, compared to among suspected strokes, in our study and more consistent with published estimates. Recent research demonstrating associations between EMS prenotification and reduced stroke treatment times had substantially greater prenotification and data from predominantly large tertiary care centers in urban areas.[30,31] Given the observed differences in rural and low SES areas, additional research on the effects of stroke prenotification are needed in less-resourced settings.

With EMS prenotification as a key component of stroke systems of care,[32] our findings support additional efforts to improve this practice, particularly in rural and poorer communities. Continuing education and quality improvement in EMS can help address suboptimal adherence to current prehospital stroke protocols. Furthermore, the Utstein recommendations for emergency stroke care stressed the importance of a population-based stroke registry collecting data across the stroke chain of survival, including prehospital data on prenotification.[33] With prior research suggesting a disconnect between EMS prenotification policy and practice,[18] such stroke registries should be designed and executed to facilitate bidirectional data sharing and communication between EMS and hospitals.[34] This systems approach and collaboration have the potential to improve acute stroke care in underserved settings and address stroke disparities.

Our study had important strengths and weaknesses. Our study used a large statewide database of EMS encounter data collected in the standardized National EMS Information System format. By using only EMS data, our study was limited to the prehospital care of stroke and did not include any data on in-hospital care, final diagnosis, or patient outcomes. As discussed, our study population was broadly defined as any patient suspected of having a stroke by EMS and likely included stroke mimics, thus reflecting the entirety of prehospital stroke care. Making completion of a prehospital stroke screen an eligibility criterion excluded data if this information was not documented in the patient care report. Because the data are collected and maintained by a separate entity, data accuracy and completeness could not be independently verified by our study team. Although North Carolina is a large state with a diverse population, our results may not be generalizable to other states or regions. We had a high success rate with geocoding incident addresses to census tracts. Furthermore, we had adequate data to represent all levels of rurality and SES in our study. Although the urban–rural commuting area is commonly used in the literature to define rurality, there are multiple definitions to classify a community as rural versus urban, such as the Urban Influence Codes, census place, or urban area designation, and a different definition may change our results. Finally, our data are from 2019 and may not reflect the most current practices of stroke prenotification by EMS, although our findings are not influenced by disruptions and variations in prehospital emergency care resulting from the coronavirus disease 2019 pandemic.

Conclusions

Our study showed important differences in EMS prehospital notification for suspected stroke between community rurality and socioeconomic status. Responses by EMS in rural and low SES areas had the lowest rates of stroke prenotification. Our findings can inform continuing education and quality improvement initiatives to improve prehospital stroke care and optimize stroke systems at regional and state levels.

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Appendices

Table S1.

Study Data Elements (National EMS Information System V3)

Data Element Number	Data Element Name
eResponse.05	Type of Service Requested
eResponse.15	Level of Care of This Unit
eResponse.23	Response Mode to Scene
eDispatch.01	Complaint Reported by Dispatch
eScene.09	Incident Location Type
eScene.15	Incident Address
eScene.17	Incident City
eScene.18	Incident State
eScene.19	Incident ZIP Code
eScene.21	Incident County
eTimes.01	PSAP Call Date/Time
eTimes.03	Unit Notified by Dispatch Date/Time
eTimes.05	Unit En Route Date/Time
eTimes.06	Unit On Scene Date/Time
eTimes.07	Unit on Patient Date/Time
eTimes.09	Unit Left Scene Date/Time
eTimes.11	Patient at Destination Date/Time
ePatient.13	Gender
ePatient.14	Race
ePatient.15	Age
ePatient.16	Age Units

Data Element Number	Data Element Name
eSituation.04	Complaint
eSituation.05	Duration of Complaint
eSituation.06	Time Units of Duration
eSituation.09	Primary Symptom
eSituation.10	Other Associated Symptoms
eSituation.11	Primary Impression
eSituation.12	Secondary Impression
eProtocols.01	Protocols Used
eProcedures.03	Procedure
eMedications.03	Medication Given
eVitals.29	Stroke Scale Score
eVitals.30	Stroke Scale Type
eDisposition.01	Destination Name
eDisposition.02	Destination Code
eDisposition.03	Destination Address
eDisposition.04	Destination City
eDisposition.05	Destination State
eDisposition.06	Destination County
eDisposition.07	Destination ZIP Code
eDisposition.12	Incident Patient/Disposition
eDisposition.17	Transport Mode from Scene
eDisposition.21	Type of Destination
eDisposition.24	Pre-Arrival Alert or Action

Table S2.

Adjusted Odds Ratios (AORs) and 95% Confidence Intervals (CIs) of EMS Stroke Prenotification with Census Tract Urban-Rural and Socioeconomic Status Stratified by Stroke Screen Interpretation

	Positive Stroke Screen (N=5,484)		Non-Conclusive Stroke Screen (N=1,149)		Negative Stroke Screen (N=2,894)	
	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)
(a) Base model *						
Urban (ref)	1	---	1	---	1	---
Suburban	1.06	(0.94–1.21)	0.76	(0.57–1.03)	0.44	(0.34–0.57)
Rural	0.77	(0.62–0.94)	0.42	(0.25–0.73)	0.31	(0.19–0.50)
High SES (ref)	1	---	1	---	1	---
Medium SES	1.05	(0.91–1.21)	0.99	(0.68–1.45)	0.77	(0.62–0.95)
Low SES	0.91	(0.78–1.06)	0.79	(0.53–1.16)	0.64	(0.50–0.83)

	Positive Stroke Screen (N=5,484)		Non-Conclusive Stroke Screen (N=1,149)		Negative Stroke Screen (N=2,894)	
	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)
(b) Fully-adjusted model[†]						
Urban (ref)	1	---	1	---	1	---
Suburban	1.05	(0.91–1.20)	0.82	(0.58–1.15)	0.62	(0.47–0.82)
Rural	0.76	(0.61–0.96)	0.37	(0.19–0.70)	0.48	(0.29–0.81)
High SES (ref)	1	---	1	---	1	---
Medium SES	1.01	(0.87–1.18)	0.89	(0.58–1.38)	0.68	(0.53–0.87)
Low SES	0.86	(0.73–1.02)	0.68	(0.43–1.08)	0.51	(0.38–0.69)

[*] Base model includes census tract rurality and SES

[†] Fully-adjusted model includes census tract rurality and SES, age group, gender, race/ethnicity, duration of symptoms, weekend, time of day, stroke dispatch complaint, and EMS provider primary impression

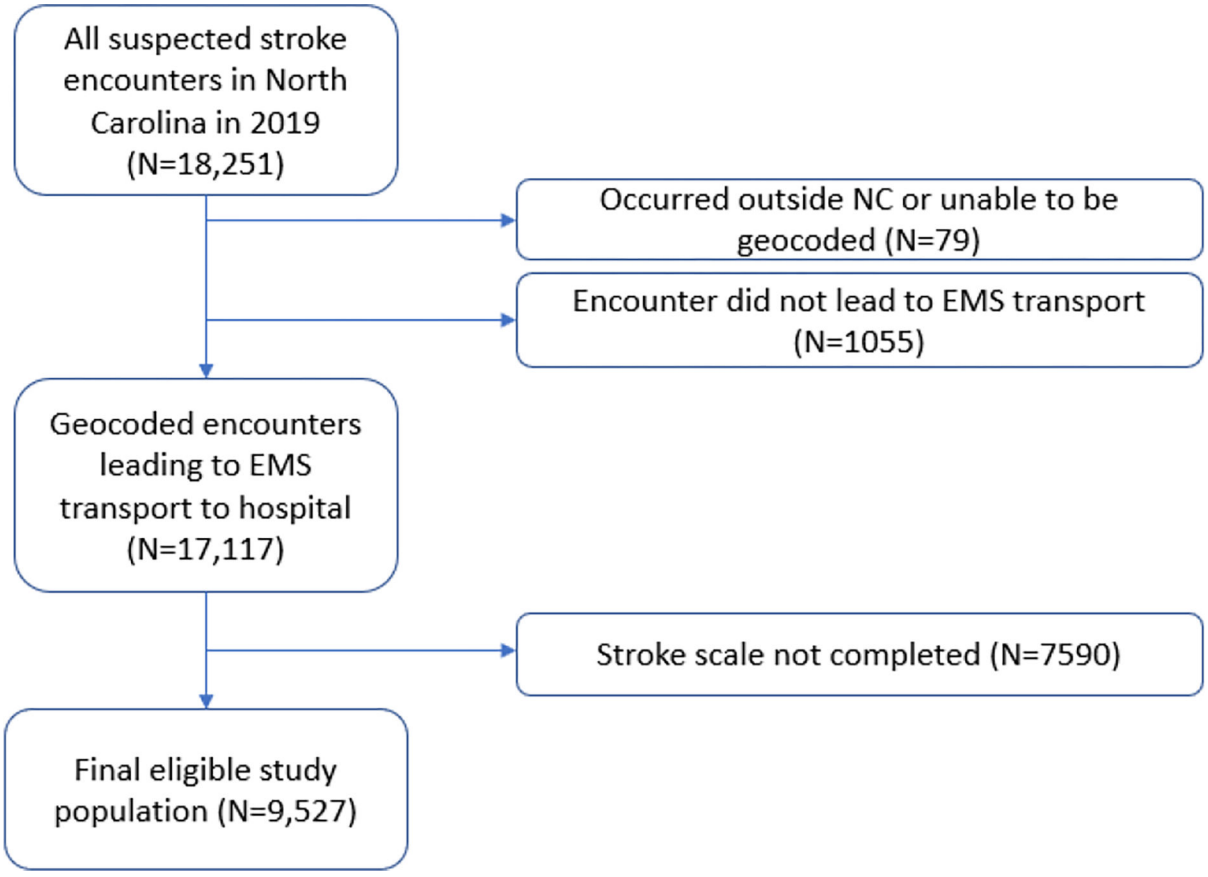

Figure S1.
Flow Diagram of the Final Study Population

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Key Points

- Community socioeconomic and urban–rural disparities in prehospital stroke care by emergency medical services (EMS) are understudied.
- This statewide study of EMS prehospital notification of stroke to the destination hospital was conducted with data on EMS stroke encounters in North Carolina in 2019.
- An EMS prehospital notification of stroke was less likely to occur in low socioeconomic status and rural communities.

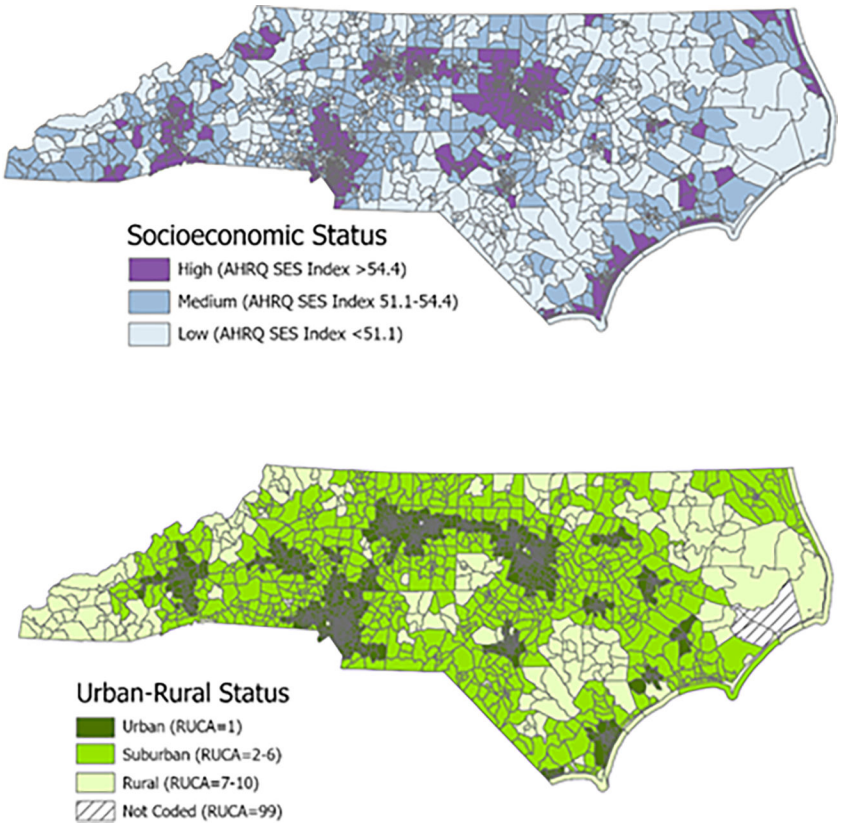

Fig. 1.

Census tract socioeconomic status and urban–rural status in North Carolina. AHRQ, Agency for Healthcare Research and Quality; RUCA, rural–urban commuting area; SES, socioeconomic status.

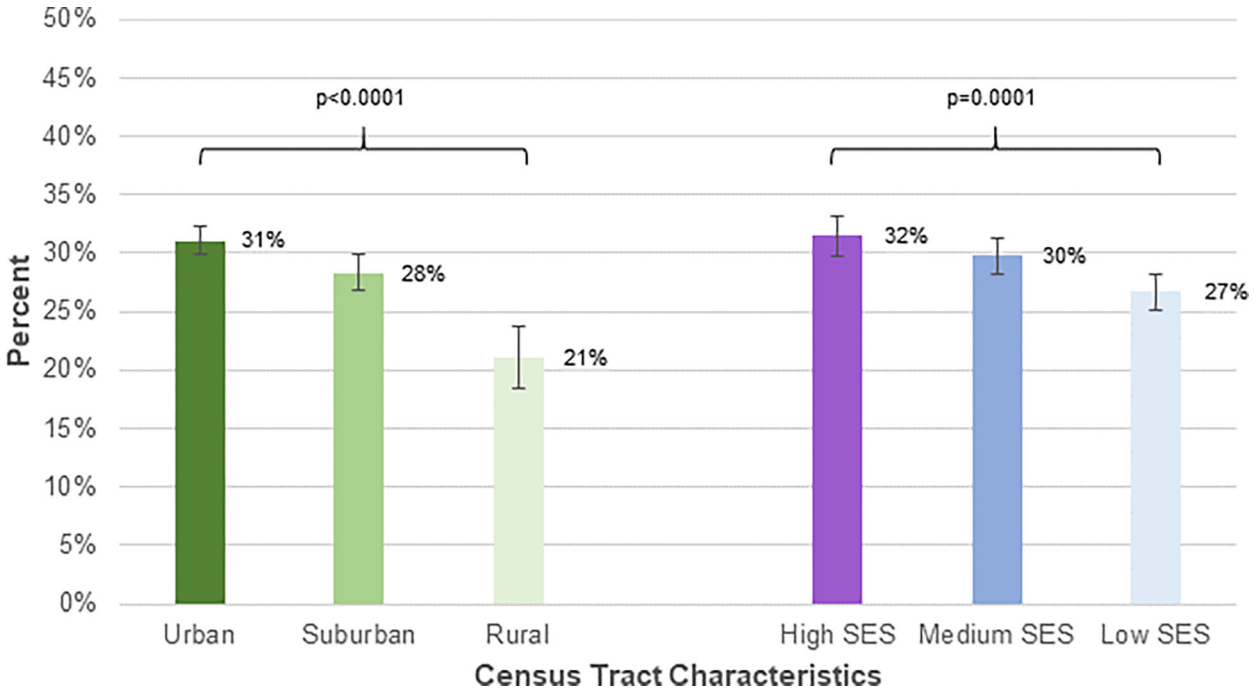

Fig. 2.

Emergency medical services prenotification of suspected stroke patients by census tract urban–rural status and socioeconomic status (N = 9527). SES, socioeconomic status.

Table 1.

Characteristics of EMS suspected stroke patients by census tract characteristics

Characteristics	Overall (N = 9527), no. (%)	Urban–rural status			Socioeconomic status		
		Urban (n = 5424), no. (%)	Suburban (n = 3217), no. (%)	Rural (n = 886), no. (%)	High (n = 2809), no. (%)	Medium (n = 3424), no. (%)	Low (n = 3294), no. (%)
Age group, y							
18–54	1498 (16)	853 (16)	510 (16)	135 (15)	375 (13)	541 (16)	582 (18)
55–64	1801 (19)	1009 (19)	631 (20)	161 (18)	416 (15)	647 (19)	738 (22)
65–74	2317 (24)	1307 (24)	805 (25)	205 (23)	655 (23)	816 (24)	846 (26)
≥75	3911 (41)	2255 (42)	1271 (40)	385 (43)	1363 (49)	1420 (41)	1128 (34)
Sex							
Female	5200 (55)	2985 (55)	1725 (54)	490 (55)	1529 (55)	1910 (56)	1761 (54)
Male	4315 (45)	2433 (45)	1487 (46)	395 (45)	1276 (45)	1509 (44)	1530 (46)
Missing	12	6	5	1	4	5	3
Race/ethnicity							
Black or African American	2479 (27)	1581 (30)	676 (22)	222 (26)	479 (17)	789 (23)	1211 (38)
White	6635 (71)	3641 (68)	2382 (76)	612 (72)	2214 (80)	2519 (75)	1902 (59)
Hispanic	138 (1)	86 (2)	41 (1)	11 (1)	47 (2)	53 (2)	38 (1)
Other	104 (1)	50 (1)	45 (1)	9 (1)	34 (1)	16 (0.5)	54 (2)
Missing	171	66	73	32	35	47	89
Duration of complaint							
<3 h	6340 (71)	3532 (70)	2191 (72)	617 (75)	1829 (72)	2298 (70)	2213 (72)
3–6 h	658 (7)	388 (8)	217 (7)	53 (6)	195 (8)	243 (7)	220 (7)
6–24 h	1314 (15)	776 (15)	440 (14)	98 (12)	359 (14)	517 (16)	438 (14)
>24 h	562 (6)	317 (6)	190 (6)	55 (7)	154 (6)	215 (7)	193 (6)
Missing	653	411	179	63	272	151	230
Weekend	2457 (26)	1383 (26)	841 (26)	233 (26)	689 (25)	881 (26)	887 (27)
Time of day							
7 AM–3 PM	2664 (28)	1503 (28)	913 (28)	248 (28)	785 (28)	925 (27)	954 (29)
3 PM–11 PM	4713 (49)	2717 (50)	1556 (48)	440 (50)	1415 (50)	1689 (49)	1609 (49)
11 PM–7 AM	2150 (23)	1204 (22)	748 (23)	198 (22)	609 (22)	810 (24)	731 (22)
Stroke complaint by 9–1–1 dispatch	5570 (58)	3147 (58)	1888 (59)	535 (60)	1712 (61)	2035 (59)	1823 (55)
EMS provider primary impression							
Stroke	7690 (86)	4484 (87)	2524 (85)	682 (85)	2334 (87)	2766 (86)	2590 (85)
Altered mental status	480 (5)	262 (5)	166 (6)	52 (6)	140 (5)	169 (5)	171 (6)
Weakness	272 (3)	154 (3)	93 (3)	25 (3)	77 (3)	112 (3)	83 (3)
Other	501 (6)	271 (5)	183 (6)	47 (6)	147 (5)	168 (5)	186 (6)
Missing	584	253	251	80	111	209	264

Characteristics	Overall (N = 9527), no. (%)	Urban–rural status			Socioeconomic status		
		Urban (n = 5424), no. (%)	Suburban (n = 3217), no. (%)	Rural (n = 886), no. (%)	High (n = 2809), no. (%)	Medium (n = 3424), no. (%)	Low (n = 3294), no. (%)
Stroke screen interpretation							
Positive	5484 (58)	2992 (55)	1978 (61)	514 (58)	1559 (56)	1958 (57)	1967 (60)
Nonconclusive	1149 (12)	557 (10)	457 (14)	135 (15)	217 (8)	426 (12)	506 (15)
Negative	2894 (30)	1875 (35)	782 (24)	237 (27)	1033 (37)	1040 (30)	821 (25)

EMS, emergency medical services.

Table 2.

Adjusted associations of EMS stroke prenotification with census tract urban–rural and SES

	AOR	95% CI
Base model[a]		
Urban (ref)	1	—
Suburban	0.91	0.83–1.01
Rural	0.62	0.52–0.74
High SES (ref)	1	—
Medium SES	0.97	0.87–1.09
Low SES	0.86	0.76–0.97
Fully adjusted model[b]		
Urban (ref)	1	—
Suburban	0.92	0.82–1.04
Rural	0.64	0.52–0.77
High SES (ref)	1	—
Medium SES	0.91	0.80–1.03
Low SES	0.76	0.67–0.88

AOR, adjusted odds ratio; CI, confidence interval; EMS, emergency medical services; ref, reference; SES, socioeconomic status.

[a]Base model includes census tract rurality and SES.

[b]Fully adjusted model includes census tract rurality and SES, age group, sex, race/ethnicity, duration of complaint, weekend, time of day, stroke dispatch complaint, EMS provider primary impression, and stroke screen interpretation.