Racial and Rural-Urban Disparities in Stroke Mortality Outside the Stroke Belt

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Objectives: Stroke disparities in relation to the Stroke Belt have been studied extensively, but little is known about stroke mortality disparities outside the Stroke Belt. We examined the hypothesis that racial and rural-urban stroke disparities exist outside the Stroke Belt.

Design, setting, participants: A county-based population study of stroke mortality in adults, aged ≥25 years, for a seven-year period (2000–2006) was conducted in the non-Stroke Belt states. Data on stroke deaths were obtained from the Centers for Disease Control and Prevention, National Center for Health Statistics. Relative risks (RR) were estimated by multivariable Poisson regression, adjusting for known confounders.

Main outcome measure: Stroke death rates.

Results: In the non-Stroke Belt states, African Americans had 1.44 times higher stroke death rates than Caucasians, 2.14 times higher than Asians/Pacific Islanders, and 1.56 times higher than American Indians (adjusted RR=1.44, $P<.001$; adjusted RR=2.14, $P<.001$; and, adjusted RR=1.56, $P<.001$, respectively). After adjusting for race, sex, and age, residents of rural counties outside the Stroke Belt still had a statistically significant 12% increase in stroke mortality compared to urban counties (adjusted RR=1.12, $P<.001$). Female sex and older age were also associated with higher stroke mortality.

Conclusions: The present study revealed that racial and rural-urban disparities in stroke mortality exist in populations residing outside the Stroke Belt. Stroke mortality in the non-Stroke Belt states is disproportionately higher in African Americans and in rural area residents. African Americans are the only racial group in which urban residency is not associated with a decrease in stroke mortality. (*Ethn Dis.* 2011;21(3):307–313)

Key Words: Stroke, Mortality, African Americans, Blacks, Racial Disparities, Rural-Urban Disparities

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Introduction

Both worldwide and in the United States, stroke constitutes a substantial health care problem and is characterized by a high burden of disease from health care and public health perspectives. Stroke is the second leading cause of death worldwide, causing more than 5.5 million deaths annually.[1] In the United States, stroke is the third and fourth leading cause of death in women and men, respectively.[2] Stroke causes about one in every 18 deaths in the United States, and stroke mortality exceeds 130,000.[3] About 2.9% of the adult Americans have had a stroke, of whom almost a third live with a disability.[3]

An excess stroke mortality has been observed in the Southeastern states for more than half a century;[4] this area of the country is known as the Stroke Belt. As defined by the National Heart, Lung, and Blood Institute (NHLBI), the Stroke Belt comprises eleven states with age-adjusted stroke mortality more than 10% above the mean national mortality,[5] namely Alabama, Arkansas, Georgia, Indiana, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. During the last two decades, the Stroke Belt phenomenon has been investigated extensively[6–11] including mortality associated with ethnic differences.[12,13] In addition, rural-urban disparities in access to emergency health care[14] and in stroke rehabilitation[15] have been reported.

Because racial and rural-urban disparities in stroke mortality outside the Stroke Belt are less well understood, we examined the hypothesis that racial and rural-urban disparities exist outside the Stroke Belt.

Methods

Study Population

We conducted a county-based ecologic study of stroke mortality for a seven-year period (2000-2006) in the states outside the Stroke Belt in relation to race and rural status. Stroke mortality data were obtained from the United States Department of Health and Human Services (US DHHS), National Center of Health Statistics (NCHS), Centers for Disease Control and Prevention (CDC) in the Compressed Mortality File format from the CDC WONDER database.[16] The I60–I69 codes of the International Classification of Diseases, 10th Revision (ICD-10) were used to identify deaths from stroke (cerebrovascular disease). Each county's data included the number of stroke deaths relative to the total population stratified by age, sex, and race.

Rural status (rural/urban) was defined for each county using an established county Rural-Urban Continuum Code (RUCC) system by the United States Department of Agriculture (USDA) Economic Research Service. Developed by Calvin Beale, the RUCC system is often referred to as the Beale

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Code system. The continuum of codes ranges from 1 (counties in metro areas of 1 million population or more) to 9 (completely rural or less than 2,500 urban population, not adjacent to a metro area). Codes 1 to 3 inclusive are metro counties; codes 4 to 9 inclusive are non-metro counties. Using the USDA Economic Research Service's (2007) approach, we classified a county as rural if it belonged to the non-metro category (codes 4 through 9); as urban, if it belonged to the metro category (codes 1 through 3).[17]

Table 1. Demographic characteristics of the study population by the rural status (2000–2006), person-years of study period (%)

Population Groups	Rural	Urban	Total
Race			
African Americans	4,057,203 (4.1)	95,734,359 (95.9)	99,791,562 (100.0)
Asians	2,018,810 (3.7)	52,486,520 (96.3)	54,505,330 (100.0)
American Indians	3,354,169 (31.5)	7,283,616 (68.5)	10,637,785 (100.0)
Caucasians	142,439,521 (16.1)	743,925,798 (83.9)	886,365,319 (100.0)
Age			
25–34 years	26,897,431 (12.2)	194,185,636 (87.8)	221,083,067 (100.0)
35–44 years	32,163,025 (13.0)	215,286,370 (87.0)	247,449,395 (100.0)
45–54 years	32,889,152 (14.5)	193,704,056 (85.5)	226,593,208 (100.0)
55–64 years	24,262,059 (15.8)	129,315,391 (84.2)	153,577,450 (100.0)
65–74 years	17,985,972 (17.5)	84,841,254 (82.5)	102,827,226 (100.0)
75–84 years	12,687,333 (17.5)	59,984,997 (82.5)	72,672,330 (100.0)
≥85 years	4,984,731 (18.4)	22,112,589 (81.6)	27,097,320 (100.0)
Sex			
Males	77,579,853 (14.2)	467,547,527 (85.8)	545,127,380 (100.0)
Females	74,289,850 (14.7)	431,882,766 (85.3)	506,172,616 (100.0)
Total population	151,869,703 (14.4)	899,430,293 (85.6)	1,051,299,996 (100.0)
Number of counties	1,441	665	2,106

Statistical Analysis

The primary outcome variable was stroke mortality. Stroke mortality rates (per 100,000 person-years, over a 7-year period) were calculated as a number of stroke deaths divided by the population residing in a given county multiplied by 100,000.

All statistical analyses were performed with the SAS software, version 9.2 (SAS Institute Inc., Cary, NC). A conventional value of $P<.05$ (type I error alpha=.05) was used for all data analyses.

Both unadjusted (ie, crude, not controlled for confounders) and adjusted analyses of stroke mortality were conducted. Unadjusted analysis was conducted first and provided preliminary results of the distribution of stroke mortality across different population groups outside the Stroke Belt. The adjusted analysis (multivariable Poisson regression) provided a deeper insight into stroke mortality patterns in relation to rural status and race, adjusting for demographic confounders.

Relative risks (RR) of stroke death were calculated as stroke mortality rate ratios. In unadjusted analysis, stroke death rates were compared by rural status, sex, race/ethnicity (African Americans [Blacks], Caucasians [Whites], Asians, and American Indians), and age (by 10-year increment categories for 25–84 years and >85 years category, as available in the CDC WONDER database).[16] For unadjusted analysis of stroke mortality and testing for statistical significance of unadjusted RR, chi-square statistic was calculated.[18] For comparison of unadjusted stroke mortality across age groups, Mantel-Haenszel chi-square test for trend was used. For multiple comparisons, Bonferroni correction was applied.[19]

For adjusted analysis, the multivariable Poisson regression was used to obtain RR and their respective 95% confidence intervals (CI).[19] To control for confounding by race, sex, age, and rural status, these variables were included in the model. A scaling factor was used to adjust for overdispersion; the scaled Pearson chi-square was equal 1. Because the rural status and demographic characteristics of the study population were obtained on a county level, adjusted stroke mortality rates were calculated on a county level. To adjust for clustering of observations within counties, the generalized estimating equations (GEE) method was used. The PROC GENMOD procedure of the SAS was used to conduct the multivariable Poisson regression and GEE analysis.

RESULTS

The study population consisted of adults, aged ≥25 years, residing outside the Stroke Belt, yielding a total study population of 150,185,714, representing 128,490,042 (85.6%) from urban counties and 21,695,672 (14.4%), from rural counties. Of the ethnic minority groups, African Americans (Blacks) constituted the largest one (99,791,562 person-years and 9.5% of the study population). Asians constituted 5.2% of the study population (54,505,330 person-years) and American Indians, 1.0% (10,637,785 person-years). Caucasians (Whites) constituted 84.3% of the study population (886,365,319 person-years). The distribution of the demographic characteristics of the study population by rural status is presented in Table 1.

American Indians had the highest proportion of the rural population (31.5%), as compared to Caucasians (16.1%); African Americans (4.1%), and Asians (3.7%). Chi-square test for the residential rural-urban differences across racial groups was statistically significant ($P<.001$) (Table 1).

Table 2. Unadjusted stroke mortality rates (per 100,000 person-years) and unadjusted relative risk of stroke mortality in populations residing outside the Stroke Belt

Population Characteristics	Unadjusted Stroke Mortality (95% CI), Per 100,000 Person-years	Unadjusted RR (95% CI)	*P*
Race			
African American, reference	74.22 (73.69–74.76)	1.0	
Asians	42.73 (42.18–43.28)	.57 (.56–.58)	<.001
American Indians	32.69 (31.60–33.77)	.44 (.42–.46)	<.001
Caucasians	82.70 (82.51–82.89)	1.11 (1.10–1.12)	<.001
Rural Status			
Urban, reference	75.31 (75.14–75.49)	1.0	
Rural	103.02 (102.51–103.53)	1.37 (1.36–1.38)	<.001
Sex			
Females, reference	64.30 (64.08–64.52)	1.0	
Males	93.26 (93.01–93.52)	1.45 (1.44–1.46)	<.001
Age, years			
25–34, reference	1.30 (1.25–1.35)	1.0	<.001*
35–44	4.89 (4.80–4.97)	3.76 (3.61–3.91)	
45–54	13.73 (13.57–13.88)	10.55 (10.16–11.00)	
55–64	32.94 (32.65–33.23)	25.31 (24.39–26.30)	
65–74	105.71 (105.08–106.33)	81.23 (78.33–84.35)	
75–84	385.51 (384.08–386.94)	296.24 (285.75–307.54)	
≥85	1285.56 (1281.29–1289.83)	987.89 (952.92–1025.51)	

* *P* for trend, Wald statistic.

Rural status increased with age: 12.2% of residents in the 25–34 year-old age group, 13.0% in the 35–44 year-old group, 14.5% in the 45–54 year-old group, 15.8% in the 55–64 year-old group, 17.5% in the 65–74 year-old and 75–84 year-old groups; 18.4% in the 85-year-and-older age group. Mantel-Haenszel chi-square test for this trend was statistically significant ($P<.001$) (Table 1).

During the seven-year study period, a total of 833,864 stroke deaths occurred in the study population. Unadjusted stroke mortality outside the Stroke Belt (Table 2) was 37% higher in rural counties than in urban ones (RR=1.37, $P<.001$). Male stroke mortality outside the Stroke Belt was 45% higher than female stroke mortality (RR=1.45, $P<.001$). Unadjusted (crude) stroke mortality rates among Asians/Pacific Islanders and American Indians were, respectively, 43% and 56% lower than among African Americans (RR=.57, $P<.001$; and RR=.44, $P<.001$, respectively). Among Caucasians, unadjusted (crude) stroke mortality was 11% higher than among African Americans (RR=1.11, $P<.001$). As expected, a statistically significant ($P<.001$) increase in stroke mortality with an increase in age was observed across all age groups. Notably, crude stroke mortality (ie, unadjusted for demographic characteristics, such as age) is higher in Caucasians than in African Americans, but this finding differs from adjusted stroke mortality, as discussed below.

To investigate the effect of rural status on stroke mortality, we performed a stratified analysis of stroke mortality in rural and urban counties separately (Table 3). The stratified analysis indicated that, in all racial groups, stroke mortality was statistically significantly higher in rural counties than in urban ones ($P<.001$): a rurality-related increase in stroke mortality among African Americans, Asians/Pacific Islanders, American Indians, and Caucasians was 20%, 63%, 76%, and 34%, respectively (Table 3). In rural areas outside the Stroke Belt, females and males, respectively, have 34% and 40% higher stroke mortality ($P<.001$) than their counterparts in urban areas (Table 3). In respect to age, a statistically significant increase in stroke mortality in rural population ($P<.01$) was observed only in older age groups – 65 years and older (Table 3). The rural-urban stroke mortality gap in the older populations increased with age: a 4% gap in 65–74 year-old age group, an 8% gap in 75–84 year-old age group, and a 13% gap in 85-year-and-older age group.

The adjusted analysis demonstrated the existence of racial and rural-urban disparities stroke mortality outside the Stroke Belt (Table 4). After controlling for the rural status, sex, and age, African Americans had 1.44 times higher stroke mortality rates than Caucasians, 2.14 times higher than Asians/Pacific Islanders, and 1.56 times higher than American Indians (adjusted RR=1.44, $P<.001$; adjusted RR=2.14, $P<.001$; and, adjusted RR=1.56, $P<.001$, respectively). After controlling (adjusting) for race, sex, and age, residents of rural counties outside the Stroke Belt still had a statistically significant 12% increase in

Table 3. Unadjusted stroke mortality rates (per 100,000 person-years) in rural and urban populations outside the Stroke Belt in relation to race, sex and age

Population Characteristics	Unadjusted Stroke Mortality (95% CI), Per 100,000 Person-years	Unadjusted RR (95% CI)	*P**
Race			
African Americans			
Urban, reference	73.63 (73.09–74.18)	1.0	
Rural	88.19 (85.30–91.08)	1.20 (1.16–1.24)	<.001
Asians			
Urban, reference	41.76 (41.20–42.31)	1.0	
Rural	68.11 (64.51–71.71)	1.63 (1.54–1.72)	<.001
American Indians			
Urban, reference	26.35 (25.17–27.53)	1.0	
Rural	46.45 (44.14–48.76)	1.76 (1.65–1.88)	<.001
Caucasians			
Urban, reference	78.38 (78.18–78.58)	1.0	
Rural	105.27 (104.74–105.80)	1.34 (1.33–1.35)	<.001
Sex			
Females			
Urban, reference	61.28 (61.05–61.52)	1.0	
Rural	81.84 (81.19–82.49)	1.34 (1.33–1.35)	<.001
Males			
Urban, reference	88.28 (88.01–88.55)	1.0	
Rural	123.30 (122.52–124.09)	1.40 (1.39–1.41)	<.001
Age			
25–34 years			
Urban, reference	1.29 (1.24–1.34)	1.0	
Rural	1.36 (1.22–1.50)	1.05 (.94–1.16)	.393
35–44 years			
Urban, reference	4.88 (4.79–4.97)	1.0	
Rural	4.92 (4.67–5.16)	1.01 (.96–1.06)	.796
45–54 years			
Urban, reference	13.86 (13.70–14.03)	1.0	
Rural	12.92 (12.53–13.31)	.93 (.90–0.96)	<.01
55–64 years			
Urban, reference	32.86 (32.55–33.18)	1.0	
Rural	33.34(32.61–34.07)	1.01 (.99–1.03)	.236
65–74 years			
Urban, reference	104.91 (104.22–105.59)	1.0	
Rural	109.48 (107.95–111.01)	1.04 (1.02–1.06)	<.01
75–84 years			
Urban, reference	380.47 (378.91–382.03)	1.0	
Rural	409.35 (405.82–412.87)	1.08 (1.07–1.09)	<.01
≥85 years			
Urban, reference	1256.32 (1251.65–1260.99)	1.0	
Rural	1415.28 (1404.84–1425.73)	1.13 (1.12–1.14)	<.01

* With Bonferroni correction for multiple comparisons.

stroke mortality compared to urban counties (adjusted RR=1.12, *P*<.001). Adjusted analysis also demonstrated that female sex and older age were associated with higher stroke mortality (Table 4).

Analysis of interaction effects between rural status and race revealed that for all racial groups, except African Americans, urban residency was associated with lower stroke mortality. Adjusted RR for rural-vs-urban stroke mortality was 1.12 for Caucasians (*P*<.001), 1.71 for American Indians (*P*<.001), and 1.26 for Asians (*P*<.001) (data not shown). For African Americans, residency in urban areas was not associated with a statistically significant decrease in stroke mortality, compared to rural areas (adjusted RR=1.02 for rural-vs-urban stroke mortality, *P*=.698).

Discussion

About 80% of the adult US population live outside the Stroke Belt and account for more than 77% of all stroke deaths in the country (which translates into nearly 120,000 stroke deaths a year).[3] The issue of investigating racial and rural-urban disparities in stroke mortality in this population is imperative from both public health, health care, and health policy decision-making perspectives.

Our study has revealed that racial and rural-urban disparities in stroke mortality exist in the non-Stroke Belt states. Previous research has shown that stroke incidence and mortality within the Stroke Belt is higher than outside the Stroke Belt,[4,11] and stroke mortality disparities in relation to the Stroke Belt have been studied intensively.[12,13,20,21] Our findings contribute new knowledge to the literature by demonstrating that racial and rural-urban disparities in

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Table 4. Adjusted relative risk of stroke mortality outside the Stroke Belt in relation to race and rural status

Parameter	β coefficient	Standard Error	Adjusted RR (95% CI)	*P*
Blacks, compared to Whites*	.3669	.0261	1.44 (1.37–1.52)	<.001
Blacks, compared to American Indians*	.7619	.0549	2.14 (1.92–2.39)	<.001
Blacks, compared to Asians/Pacific Islanders*	.4472	.0410	1.56 (1.44–1.69)	<.001
Rural, compared to urban †	.1098	.0181	1.12 (1.08–1.16)	<.001
Females, compared to males ‡	.0408	.0045	1.04 (1.03–1.05)	<.001
Age, years, compared to 25–34§				<.001 ǁ
35–44	1.3588	.0262	3.89 (3.70–4.10)	
45–54	2.4046	.0272	11.07 (10.50–11.68)	
55–64	3.2879	.0268	26.79 (25.42–28.23)	
65–74	4.4592	.0292	86.42 (81.61–91.51)	
75–84	5.7641	.0320	318.65 (299.32–339.27)	
≥85	6.9739	.0339	1068.38 (999.64–1141.73)	

* Adjusted for rural status, sex, and age.
† Adjusted for race, sex, and age.
‡ Adjusted for rural status, race, and age.
§ Adjusted for rural status, race, and sex.
ǁ *P* for trend, Wald statistic.

stroke mortality exist in populations residing outside the Stroke Belt.

In the present study, we found that adjusted and unadjusted risks of stroke death in relation to race are different. Difference between adjusted and unadjusted values is common in observational (non-experimental) studies; it indicates the presence of confounding effect. In the presence of confounding, conclusions about the association between a characteristic of interest (such as race) and risk of stroke death should be made based on the adjusted RR, not on the unadjusted RR distorted by confounding. Reporting both the adjusted and unadjusted RR provides the audience with information on the magnitude of confounding effect; we followed this results reporting practice, which is common and recommended in epidemiological literature.[19]

Compared to other racial groups, African Americans had the highest stroke mortality in the non-Stroke Belts states, with the elevated risk of fatal stroke being independent from rural status, age, and sex. For African Americans, risk of stroke death was 44% higher than for Caucasians (adjusted RR=1.44). Because we utilized multivariable analysis to adjust for potential confounders, these findings cannot be attributed to demographic differences (age and sex) between populations of different counties. Residents of rural counties in the non-Stroke Belt states had a 12% higher risk of stroke death than those living in urban counties (adjusted RR=1.12).

While in Caucasians, American Indians, and Asians, stroke mortality was statistically significantly lower in urban than in rural counties, we did not observe such a gradient in African Americans in our study. Lack of urban-rural mortality gradient combined with the highest stroke mortality in African Americans, as compared to other racial groups, is indicative of the need of improving stroke prevention efforts in African American communities.

Several factors should be considered when explaining disparities in stroke mortality in our study. Firstly, stroke mortality is not determined by stroke incidence only; stroke case-fatality, which can vary in different stroke patient groups, is another important determinant. Stroke mortality in a particular population group can be viewed as a function of how fast new cases of stroke occur in the population (stroke incidence) and how many stroke cases have a lethal outcome (stroke case-fatality). It should be noted that stroke case-fatality depends not only on the severity of stroke, but also on availability, accessibility, and utilization of appropriate health care by a patient in a timely manner. Secondly, while stroke incidence disparities are determined by disproportionate distribution of stroke risk factors, stroke case-fatality disparities can be determined by other factors, such as delay in treatment initiation.

Optimal treatment of ischemic stroke involves saving brain tissue from infarction (death of brain tissue due to severe ischemia) and is governed by the "time is tissue" concept. Within the first 180 minutes after the development of ischemic stroke, thrombolytic (blood clot dissolving) therapy can be administered, but after that time risks of thrombolytic therapy outweigh its benefits. Emergency access to health care is crucial for providing these patients with life-saving and disability-preventing treatment, before the three-hour window of opportunity closes.[22] The 12% increase in stroke mortality among rural populations that we found in our study is potentially attributable to factors such as distance- and time-determined barriers to emergency medical transportation, and the lower density of specialty health care facilities in rural areas, compared to urban areas. Geographic barriers have been shown to be a major determinant of stroke patients' access to emergency medical care in rural areas.[20,23]

Higher prevalence of stroke risk factors results in higher stroke incidence in African Americans. African American men and women have a higher prevalence of hypertension than Caucasian men and women.[5] Mean systolic blood pressure is also higher in African American men and women (132 and 130 mm Hg, respectively) than in Caucasian men and women (127 and 123 mm Hg, respectively).[4] African American also have higher prevalence of diabetes mellitus (30% of men, 28% of women) and smoking (19% of men, 15% of women) than Caucasians (diabetes mellitus: 17% of men and 12% of women; smoking: 11% of men, 13% of women).[4]

Lower socioeconomic status (SES) is associated with higher stroke mortality.[24] SES disparities are also associated with many risk factors for stroke and atherosclerosis, including hypertension, smoking, diabetes, and obesity.[25,26] SES, as measured by income and educational attainment, is lower among African Americans than Caucasians.[27] In a study of racial and socio-economic disparities in stroke and heart disease risk factors, Hayes et al found that a multiple-risk-factor status (having two or more risk factors) was associated with lower education and lower income; African Americans and Native Americans, but not Asians, were significantly more likely to have multiple risk factors than Caucasians.[28]

Access to health care can be impacted by a number of barriers, including not only barriers to potential care – such as spatial accessibility (distance- and time-determined travel impedance) or availability (supply level of health care facilities available for a patient to choose from) – but also barriers to realized care (health care services actually utilized by patient).[20,29] Barriers to optimal health care can contribute substantially to stroke mortality disparities.

Primary care is essential for both primary and secondary prevention of disease, including stroke. Its underutilization by African Americans is another factor contributing to higher risk of stroke. In 2007, Caucasians had an annual average of 2.40 ambulatory visits, while African Americans averaged only 2.16 ambulatory visits.[30]

Emergency department waiting time (EDWT) for stroke patients is higher for African Americans than for Caucasians. Karve et al found that 55% of Caucasian stroke patients experienced EDWT over 10 minutes, compared to 70% of African American stroke patients.[31]

African Americans have higher stroke case-fatality that translates into lower stroke survival, as compared to Caucasians. In-hospital stroke fatality among 25-49 year old adults reaches 10% in African Americans and 9% in Caucasians.[32] Difference in stroke survival exists among elderly patients too; African American Medicare beneficiaries have lower stroke survival probability then Caucasian Medicare beneficiaries.[33]

Our study is not free from limitations. As in any ecologic design study, we did not have individual-level information on study population; only group-level (county-level) information on stroke mortality and demographic characteristics was available. Group-level (ecologic) measurements are a common limitation for this type of study and make these studies vulnerable to ecologic fallacy issue that prevents extrapolating group-level findings to the individual level.[34] Nevertheless, ecologic studies remain an important and widely used in contemporary public health research type of epidemiologic studies: they constitute the core part of the modern spatial epidemiology and remain the predominant design in studies focused on so-called ecologic effects, such as evaluation of population-level effects of social processes and public health interventions.[34] Due to the ecologic design nature of our study, we were unable to investigate the effect of individual-level risk factors, such as smoking, atherogenic dyslipidemias (misbalances in cholesterol and other lipids levels causing atherosclerosis), diet and other life style-related factors. It should be noted, however, that while these effects are of interest and worth being investigated further in future studies, our goal was to investigate an ecologic, ie, population-level, disparities in stroke mortality in the non-Stroke Belt states.

In conclusion, in the present study we demonstrated that racial and rural-urban disparities in stroke mortality exist outside the Stroke Belt. Stroke mortality in the non-Stroke Belt states is disproportionately higher in African Americans and in rural area residents. African Americans are the only racial group in which urban residency is not associated with a decrease in stroke mortality. Further studies, investigating the exact causes of these disparities in the non-Stroke Belt states, are warranted.

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