Impact of Nativity and Race on “Stroke Belt” Mortality
Daniel T. Lackland, Brent M. Egan, Patricia J. Jones

Abstract—The southeastern region of the United States has been recognized for 6 decades as an area of excess cerebrovascular mortality rates. While the reasons for the disease variation remain an enigma, South Carolina has consistently been the forerunner of the “Stroke Belt.” To determine the effects of nativity (birthplace) on stroke mortality rates in South Carolina, proportional mortality ratios (PMRs) were calculated for stroke deaths in South Carolina during 1980–1996 according to birthplace and stratified by gender, race, age, and educational status. The analyses revealed a graded risk of stroke by birthplace, with the highest PMRs (95% CI) among individuals born in South Carolina (104.8 [103.4 to 106.3]), intermediate PMRs in those born in the Southeast other than South Carolina (92.5 [90.2 to 94.9]), and lowest PMRs for those born outside the Southeast (77.4 [74.9 to 80.1]). The lower stroke PMRs for individuals born outside the Southeast were more striking in blacks (51.8 [45.2 to 59.3]) than in whites (84.9 [82.0 to 88.0]) and for men (73.3 [69.5 to 77.3]) than women (83.5 [79.9 to 87.3]). The findings, particularly in blacks, were not explainable by gender, differences in age, and/or markers of educational and socioeconomic status. These findings suggest that nativity is a significant risk marker for the geographic variation in stroke mortality. Moreover, the regional disparities for nativity and subsequent stroke mortality appear to be greater in blacks than in whites and for men than for women. An understanding of factors linking birthplace to risk for cerebrovascular mortality could facilitate efforts directed at stroke prevention. (Hypertension. 1999;34:57-62.)

Key Words: stroke ■ nativity ■ race ■ proportional mortality ratios ■ epidemiology

Higher stroke mortality in the southeastern United States has been documented over the past 6 decades.1 The explanation for the Southeast “Stroke Belt” remains an enigma.1–3 In fact, Perry and Roccella4 have identified several directions for future investigations in this region of excess risks. Racial factors may contribute to the Stroke Belt. Blacks, who constitute a greater percentage of the population in the Southeast compared with other regions, have higher rates of hypertension-related complications such as stroke and end-stage renal disease than whites.5,6 However, the excess stroke mortality in the Southeast crosses demographic lines.1–4 Thus, the Stroke Belt cannot be attributed to race alone. Among the more intriguing possibilities, Fang and colleagues7 suggested that birthplace was a significant cardiovascular risk factor and might contribute to geographic variations in cardiovascular disease. These authors observed that the higher stroke mortality rates among blacks than whites in New York City are explained in large part by the very high rates among black immigrants from the South.

South Carolina (SC) has maintained for most of the past 6 decades the highest stroke mortality per capita in the United States, with cerebrovascular death rates 50% to 60% higher than the national average.3,4 Consequently, factors contributing to the excess risks in the Stroke Belt, eg, “nativity” (birthplace), may be most apparent in SC and could provide clues to the regional problem. The purpose of this study was primarily to assess whether individuals immigrating to SC from other Stroke Belt states in the Southeast as well as from areas of lower risk outside the Southeast had stroke mortality more consistent with nativity than residence at the time of death.

Although the excess of stroke mortality in the Southeast crosses demographic lines, blacks living in the Stroke Belt experience a greater excess of cerebrovascular deaths than do whites who live in this region.3,4 Thus, a secondary objective of this study was to assess whether nativity had a greater impact on stroke mortality in blacks than in whites. Data on age, gender, socioeconomic status, and educational status for the various race and birthplace subgroups were assessed to account for some of the more likely confounding variables.

Methods

Data Sources and Characteristics

Mortality Data
The SC Death File from the Public Health Statistics and Information Systems was used for this assessment. Records of death were examined for the years 1980–1996 inclusive, with death for cerebrovascular disease defined by International Classification of Dis-
TABLE 1. Percentage of All Deaths Attributed to Stroke by Place of Birth and Death Cohort Characteristics, SC 1980–1996

<table>
<thead>
<tr>
<th>Place of Birth</th>
<th>Race</th>
<th>Age, y</th>
<th>Gender</th>
<th>Education, y</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>White</td>
<td>&lt;55</td>
<td>≥55</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>SC</td>
<td>8.3</td>
<td>10.1</td>
<td>3.8</td>
<td>16.4</td>
<td>7.0</td>
</tr>
<tr>
<td>Southeast, excluding SC</td>
<td>7.8</td>
<td>9.2</td>
<td>2.9</td>
<td>9.0</td>
<td>5.9</td>
</tr>
<tr>
<td>Out of Southeast</td>
<td>6.8</td>
<td>5.1</td>
<td>2.4</td>
<td>7.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Total</td>
<td>8.0</td>
<td>9.9</td>
<td>3.5</td>
<td>10.0</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Values are percentage of deaths due to stroke.

A 95% CI, based on the natural log method, was used to compare the variation of the PMRs. The CI was computed as follows:

Lower CI = PMR × e^{(−1.96 × SE)}

Upper CI = PMR × e^{(1.96 × SE)}

where $v = 1/di−1/d+1/Di−1/D$, $e=2.7183$, $d$ is number of deaths in a geographic place of birth, $d_i$ is number of deaths from cerebrovascular disease in a geographic place of birth, $D$ is number of deaths from all causes in the total population, and $D_i$ is number of deaths from cerebrovascular disease in the total population.

Specific geographic birthplace PMRs are considered to be significantly greater than the population when the lower limit of the 95% CI is >100. The geographic birthplace area PMRs are considered significantly lower than the population when the upper limit of the 95% CI is <100. The stroke PMRs for each of the 3 birthplaces were stratified by race, gender, age (<55 versus ≥55 years), and educational status (<12 versus ≥12 years of education).

Results

Birthplace of South Carolinians

The majority (68.5%) of SC residents were born in the state, with an additional 16.9% born in other states of the Southeast. Significant racial differences by birthplace were detected, with a greater percentage of blacks born in the state and in the Southeast (87.3%, 93.7%) compared with the respective percentages in whites (61.2%, 82.6%).

Total Mortality and Deaths From Stroke

During 1980–1996, there were 478,650 total deaths in SC. As expected, most (89.6%) of these deaths occurred among individuals born in the Southeast (73.7% born in SC and 15.9% born in the Southeast other than SC). Similar patterns were detected for the 41,189 stroke deaths, with 91.9% of victims (77.2% born in SC and 14.7% in Southeast other than SC) born in the Southeast. Racial differences were also detected, with only 1.3% of the black stroke deaths born out of the Southeast compared with 11.9% of the white stroke deaths.

Approximately two thirds (67.9%) of the total deaths occurred in whites. Cerebrovascular disease was the underlying cause of death in 8.6% of cases. Stroke was more often a cause of death in blacks than in whites (9.9% versus 8.0%).

In addition, the percentage of all deaths attributed to stroke varied by birthplace (Table 1). The percentage of deaths from stroke was highest for individuals born in SC (9.0%), intermediate for those born in the Southeast (8.0%), and lowest among the group born outside the Southeast (6.7%). This pattern was consistent for whites and blacks. Similar patterns...
were detected for gender, with the lowest proportion of stroke deaths among the men and women born outside the Southeast. The geographic pattern of stroke mortality persisted when the percentage of stroke deaths was stratified by age (<55 versus ≥55 years) and educational status (<12 versus ≥12 years), i.e., the highest percentage of deaths due to stroke was for individuals born in SC.

Proportional Mortality Ratios
Stroke mortality in SC is determined mainly by the natives of SC, who constitute the overwhelming majority of individuals both living and dying in the state. Nevertheless, as seen in Figure 1, the stroke PMR (95% CI) is significantly >100.0 for residents born in SC (104.8 [103.4 to 106.3]). Stroke PMRs are significantly <100.0 for residents born in the Southeast but outside of SC (92.5 [90.2 to 94.9]) and for those born outside the Southeast (77.4 [74.9 to 80.1]). As shown in Figure 1, the lower stroke PMRs in SC among those born outside the Southeast were more apparent in blacks (51.8 [45.2 to 59.3]) than in whites (84.9 [82.0 to 88.0]). Significant gender-related differences were detected for stroke deaths. As seen in Table 1, women had a higher percentage of deaths attributed to stroke than men (10.9% versus 6.6%). Nonetheless, there was a pattern of higher PMRs in native South Carolinians and lowest ratios for individuals born outside the Southeast (Figure 2). Gender-related differences for stroke deaths for those born outside of the Southeast were evident, with men having lower PMR (73.3 [69.5 to 77.3]) than women (83.5 [79.9 to 87.3]).

Stratification of Stroke PMRs by Age
Blacks moving to SC from outside the Southeast were younger on average than blacks born in SC. Conversely, whites moving to SC from outside the Southeast were older on average than whites born in SC. Since age is strongly related to stroke mortality, stroke PMRs were recalculated after stratification by age (<55 and ≥55 years) (Figure 2).

When the PMRs were stratified by age <55 and ≥55 years, the same pattern of stroke PMRs by birthplace was observed, with the highest values for those born in SC, intermediate values for those born in the Southeast, and lowest values for those born outside the Southeast. When stratified by race as well as age, significantly lower stroke PMRs were seen for blacks aged <55 years and for both whites and blacks aged ≥55 years who were born outside the Southeast.

Socioeconomic and Educational Status of South Carolinians by Birthplace
Table 2 describes the age, educational level, poverty level, and unemployment status of SC residents from the 1990 census. For both races combined, individuals born outside the Southeast are older on average than those born in SC and the Southeast. Those born outside the Southeast were more likely to be college educated and less likely to fall below the poverty level compared with individuals born in SC and the Southeast. However, employment status was similar for each of the 3 birthplaces. For whites, individuals born outside the Southeast were more likely to be college educated, and less likely to fall below the poverty level. In contrast, blacks born outside the Southeast were younger and were equally likely to fall below the poverty level and to be unemployed compared with blacks born in SC and the Southeast.

On the basis of the educational level reported on the stroke death certificates during 1989–1996, individuals born outside the Southeast had a mean level of education significantly greater than those born in SC or the Southeast in both age groups (aged <55 years: SC, 10.7 years; Southeast, 11.8 years; out of Southeast, 12.4 years; aged ≥55 years: SC, 8.9 years; Southeast, 9.9 years; out of Southeast, 11.6 years). These patterns were consistent for both blacks and whites.

Stratification of Stroke PMRs by Educational Level
The stroke PMRs stratified for educational level <12 and ≥12 years showed a pattern by birthplace similar to that seen...
TABLE 2. Population Characteristics of Age, Education, Poverty Level, and Unemployment Status by Birthplace in SC Based on 1990 Census

<table>
<thead>
<tr>
<th>Population Characteristics</th>
<th>Place of Birth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SC</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
</tr>
<tr>
<td>0–24</td>
<td>37.9</td>
</tr>
<tr>
<td>25–54</td>
<td>42.4</td>
</tr>
<tr>
<td>55–64</td>
<td>8.4</td>
</tr>
<tr>
<td>≥65</td>
<td>11.4</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
</tr>
<tr>
<td>≤High school</td>
<td>39.2</td>
</tr>
<tr>
<td>High school</td>
<td>49.1</td>
</tr>
<tr>
<td>College graduate</td>
<td>11.8</td>
</tr>
<tr>
<td>Below poverty level</td>
<td>17.5</td>
</tr>
<tr>
<td>Unemployment</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>White</strong></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
</tr>
<tr>
<td>0–24</td>
<td>37.6</td>
</tr>
<tr>
<td>25–54</td>
<td>40.1</td>
</tr>
<tr>
<td>55–64</td>
<td>9.1</td>
</tr>
<tr>
<td>≥65</td>
<td>13.2</td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
</tr>
<tr>
<td>≤High school</td>
<td>24.7</td>
</tr>
<tr>
<td>High school</td>
<td>64.6</td>
</tr>
<tr>
<td>College graduate</td>
<td>10.7</td>
</tr>
<tr>
<td>Below poverty level</td>
<td>9.1</td>
</tr>
<tr>
<td>Unemployment</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Black</strong></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
</tr>
<tr>
<td>0–24</td>
<td>45.1</td>
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<td>25–54</td>
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<td>55–64</td>
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<tr>
<td>≥65</td>
<td>9.6</td>
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<tr>
<td>Educational level</td>
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<td>≤High school</td>
<td>49.9</td>
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<tr>
<td>High school</td>
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</tr>
<tr>
<td>College graduate</td>
<td>6.8</td>
</tr>
<tr>
<td>Below poverty level</td>
<td>31.2</td>
</tr>
<tr>
<td>Unemployment</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Values are percentages.

in the analyses by age (Figure 2). The stroke PMRs for those born outside the Southeast were significantly lower for blacks with <12 years of education and for both blacks and whites with ≥12 years of education.

**Discussion**

The results of these analyses suggest a graded risk of death from stroke among South Carolinians by birthplace. Risk of stroke death is highest for those born in SC, intermediate for individuals both in the Southeast, and lowest for those born outside the Southeast (Table 1). The protective effect of birthplace outside the Southeast appears to be greater for blacks than for whites and larger for men than for women. Moreover, the lower stroke PMRs in blacks born outside the Southeast (Figure 1) persist after stratification by age and educational status (Figure 2). While there are some limitations of the data derived from death certificate information, a pattern of excess stroke mortality was detected for blacks and whites born in SC, especially when compared with those born outside the Southeast.

The findings in this study complement the observations reported by Fang and colleagues, which showed that blacks immigrating to New York City from the South had cardiovascular disease mortality rates that were ∼30% higher than rates for blacks born in the Northeast. The disparity between cardiovascular death rates for immigrants born in the South compared with those born in the Northeast was greater with increasing age. Moreover, immigrants from the South accounted for much of the higher stroke mortality rates among blacks than among whites for all of New York City. These observations suggest the need for further study to assess whether birthplace is a marker of other risk factors for cardiovascular disease.

Our study examined nativity from the perspective of immigration into a high-risk area (SC), while the previous study assessed the effects of immigration into a lower-risk area (New York). We found that stroke PMRs were much lower for blacks in SC who were born in areas outside the Southeast than for blacks born in SC and the remainder of the Southeast. Our findings extend the prior report by showing that the effects of nativity on stroke mortality include whites and blacks. The PMR data are consistent with reports that SC and the Southeast (Stroke Belt) have a higher cerebrovascular burden than the rest of the United States. As an additional point of confirmation, 87% of blacks in SC were born in the state, but they account for a disproportionately high 92.2% of all deaths and 93.8% of stroke deaths for blacks. The greater risks of stroke for individuals in SC is evident with the higher proportion of deaths compared with the United States (8.6% for total SC versus 6.9% for United States; white, 8.0% versus 6.9%; black, 9.9% versus 6.6%; male, 6.6% versus 5.4%; female, 10.9% versus 8.5%).

The PMR is a statistical tool for estimating whether the proportion of deaths due to stroke in persons from a specific birthplace is higher or lower than the proportion in the total population. The PMR does not measure mortality and may be inadequate as a final assessment of risk. The purpose of this study is not to draw conclusions regarding birthplace but rather to identify whether birthplace serves as a risk marker for stroke. This information could establish the basis for subsequent studies of factors contributing to geographic variation in cardiovascular disease. PMRs, like all statistical tests, have strengths as well as limitations. In this study, stroke deaths were analyzed with the use of PMRs rather than death rates per year, since a precise estimate of the denominator, ie, population by place of birth, was recorded differently for the 1980 than for the 1990 census databases. PMRs, in contrast to death rates, are not dependent on the accuracy or structure of the population denominator.
Another limitation of disease-specific mortality based on death certificates is the accuracy of the recorded cause of death. Since all deaths occurred in SC, any discrepancies between recorded and actual cause of death should have been similar for each birthplace. Another limitation is that the denominator of the PMR includes all deaths and is affected by different causes or patterns of mortality. Although adequate numbers of blacks born out of the Southeast were available for analyses, the number is relatively small, and this group could be considerably different from the black population born in SC and the Southeast. Individuals born in SC who die are more likely than those born outside the Southeast to succumb to a stroke. From the PMR data, it is not possible to determine whether this reflects a higher rate of stroke and/or a lower rate of death from other causes among native South Carolinians. Moreover, the relationship between birthplace and stroke PMR does not establish cause and effect. The link between birthplace and stroke PMR may be mediated by mutual association with other risk factors for stroke. Age, socioeconomic status, and educational level are among the more likely confounding covariables. Therefore, additional analyses were conducted to determine whether birthplace was simply serving as a surrogate for these established risk factors.

**Age Stratification**

Age is directly and strongly related to stroke mortality.56 Whites born outside the Southeast were older than individuals born in SC and the Southeast. This age difference would be expected to be associated with increased, rather than decreased, stroke mortality in whites born outside the Southeast. Conversely, blacks born outside the Southeast were younger, which would have tended to reduce the stroke mortality risks. Consequently, the stroke PMRs were stratified by age and race groups (<55 and ≥55 years). For blacks in both age strata, significantly lower stroke PMRs persisted for those born outside the Southeast compared with the other 2 nativity groups (Figure 1). Thus, age probably does not explain the protective effect of birthplace outside the Southeast on stroke PMR.

**Stratification by Gender**

While other population studies find age-adjusted stroke mortality and incidence rates to be higher for men, the higher percentage of deaths due to stroke among women suggests that women are living longer than men and are dying of conditions associated with aging.

**Socioeconomic Status**

Lower socioeconomic status is associated with higher cardiovascular death rates.13–15 According to the US Department of Commerce (Bureau of Economic Analysis, April 1993), in 1992, SC ranked 44th among the 50 states with median incomes considerably below the US average ($14,319 for SC versus $17,387 for the United States). On the basis of the 1990 census data, economic factors did not appear to explain the association of birthplace with stroke PMR, especially among blacks (Table 1). More specifically, blacks born outside the Southeast were as likely to be unemployed and to fall below the poverty level as blacks born either in the Southeast or in SC.

**Educational Status**

The level of education is inversely associated with the risk of hypertension and cardiovascular disease.16 Of note, the inverse relationship between education and blood pressure appears to be stronger in whites than in blacks.16,17 The 1990 census data indicated that both blacks and whites born outside the Southeast had higher educational levels than did those born in the Southeast and SC.

Educational status was also examined according to highest level of education attained as recorded on the death certificate during 1989–1996. In our study, both white and black individuals born outside the Southeast had a higher educational level than individuals born in SC and the Southeast. While differences in socioeconomic status identified by educational level may indeed play a role in the higher stroke proportion for native South Carolinians, the magnitude of the education differences was not sufficient to account for the dramatic disparity in the stroke PMRs. In support of this contention, the stroke PMRs for blacks and whites combined who were born outside the Southeast were significantly lower than the stroke PMRs for those born in SC in both the group with <12 years and the group with ≥12 years of education. This difference in stroke PMRs between those born in SC and outside the Southeast remained significant in blacks with <12 years of education as well as both whites and blacks with ≥12 years of schooling. As shown in Figure 2, the PMR data stratified by educational status are consistent with the impression that the protective effect of birthplace outside the Southeast on stroke PMR is greater in blacks than in whites in SC.

Thus, the differences in educational status do not appear to be of sufficient magnitude to explain the significantly lower stroke PMRs in those born outside the Southeast, especially among blacks. These conclusions are supported by the findings of Howard et al.18,19 who reported that the excess stroke mortality in the Southeast attributable to cerebrovascular risk factors, genetic factors, and lifestyle variables was unrelated to socioeconomic status.

Another facet of education status includes quality, which may vary geographically.20,21 While this study was unable to identify an indicator of quality of education, variations in the quality appear to be dependent on socioeconomic status rather than geographic factors.22

This study was not designed to determine why residents of SC born outside the Southeast had lower stroke risks but rather was designed as a mechanism to generate hypotheses regarding this enigma. Recent findings indicate that stroke incidence is also higher in the Southeast, with high rates in young adults.23 Perry and Roccella1 reported several considerations for the existence of the Stroke Belt region. The results of our study reinforce some of these proposed factors.

Our study adds to the evidence that nativity is a powerful risk marker for stroke mortality. As discussed, the mechanisms by which nativity might influence risk for cerebrovascular death are not identified by this study, although several possibilities exist. These include differences in compliance.
with medical care practices acquired from different regions,24–26 differences in dietary habits and lifestyles,27–30 transmission of genetic susceptibility for stroke among blacks originally immigrating from West Africa,31–33 and higher prevalence of low birth weight and subsequent adverse health outcomes.34–38

Conclusion
Stroke mortality rates in SC have been and remain much higher than the national average. Stroke mortality rates among South Carolinians are strongly related to birthplace. There is evidence for a graded risk of stroke by birthplace, with those born in SC at highest risk, those born in the Southeast at intermediate risk, and those born outside the Southeast at lowest risk. The beneficial impact of birthplace outside the Southeast appears to be greater for blacks than for whites, larger in men than in women, and is not readily explained by age or educational or socioeconomic status. This study was not designed to determine how nativity affects stroke mortality. However, the data suggest that this would be a productive area for further research to elucidate factors contributing to excess stroke mortality in the Southeast.

Acknowledgments
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References
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