Ethnic and Geographic Variation in Stroke Mortality Trends

Richard F. Gillum, MD; John Kwagyan, PhD; Thomas O. Obisesan, MD

Background and Purpose—Magnitude, geographic, and ethnic variation in trends in stroke within the United States require updating for health services and health disparities research.

Methods—Data for stroke were analyzed from the US mortality files for 1999 to 2007. Age-adjusted death rates were computed for non-Hispanic African Americans and European Americans aged ≥45 years.

Results—Between 1999 and 2007, the age-adjusted death rate per 100 000 for stroke declined both in African Americans and in European Americans of both genders. Among African American females, European American females, and European American males, rates declined by at least 2% annually in every division. Among African American males, rates declined little in the East and West South Central divisions where disparities in trends by urbanization level were found.

Conclusions—Between 1999 and 2007, the rate of decline in stroke mortality varied by geographic region and ethnic group. **(*Stroke*. 2011;42:00-00.)**

Key Words: African Americans ■ aging ■ cerebrovascular disorders ■ geography ■ mortality

In 2009, stroke was the fourth leading cause of death in the United States.[1,2] Many publications have detailed the ethnic and geographic variation in stroke mortality in the United States before 2000.[3,4] This report documents ethnic and geographic variation in mortality trends from stroke within the United States in the 21st century.

Materials and Methods

Deaths in 1999 to 2007 with cerebrovascular disease (International Classification of Disease, 10th Revision codes I60–I69 [1999–2007]) as the underlying cause were enumerated.[5] For non-Hispanic African Americans (AAs) and European Americans, age-adjusted death rates per 100 000 using the 2000 US standard population were computed for persons aged ≥45 years using standard methods.[5] Urbanization levels and Census divisions are defined in Supplemental Table I (http://stroke.ahajournals.org).[6]

Results

In 2005 to 2007, average annual death rates varied by state for each group (Figure; Table 1; Supplemental Tables II and II). The rates for AAs were highest in the South Atlantic, East, and West South Central states and lowest in New England and New York, whereas rates for European Americans were highest in the South Central states, including Alabama, Mississippi, and Oregon and lowest in New York, Florida, and the Southwest. Ratios of the 90th to 10th percentiles of state rates were as follows: AA females 1.5, European American females 1.5 and AA males 1.8, European American males 1.5. In 1979 to 1981, the ratios were 1.7, 1.4, 1.8, and 1.5, respectively.

In 1999 to 2007, rates declined in the 9 US Census divisions (Table 2). Relative declines tended to be greatest in the Mountain and Pacific divisions. Variation in rate of decline was greater in AAs than in European Americans. The slowest relative declines occurred in AA females in the West North Central and West South Central divisions and in AA males in the East South Central and West South Central divisions.

Furthermore, within the West South Central division for AA women, the age-adjusted rate per 100 000 was highest in small metro areas (220) and lowest in large, fringe metro areas (188). Average annual percent change was greatest in large fringe (−4.86) and small metro areas (−4.84) and least in medium metro (−1.23; Supplemental Table IV). In AA men, the age-adjusted rate per 100 000 was highest in micropolitan (nonmetro) areas (274) and lowest in large fringe metro areas (213). Relative decline was greatest in noncore (nonmetro; −5.59) and least in large central metro (−2.24; Supplemental Table IV).

Discussion

US ethnic and geographic variation in stroke mortality or morbidity has been the subject of numerous studies,[3,7–14] yet the causes of the large geographic variation in stroke mortality have yet to be fully identified. Use of the years 1999 to 2007 when only International Classification of Disease, 10th Revision was in use precluded bias due to changes in International Classification of Disease versions. High rates in

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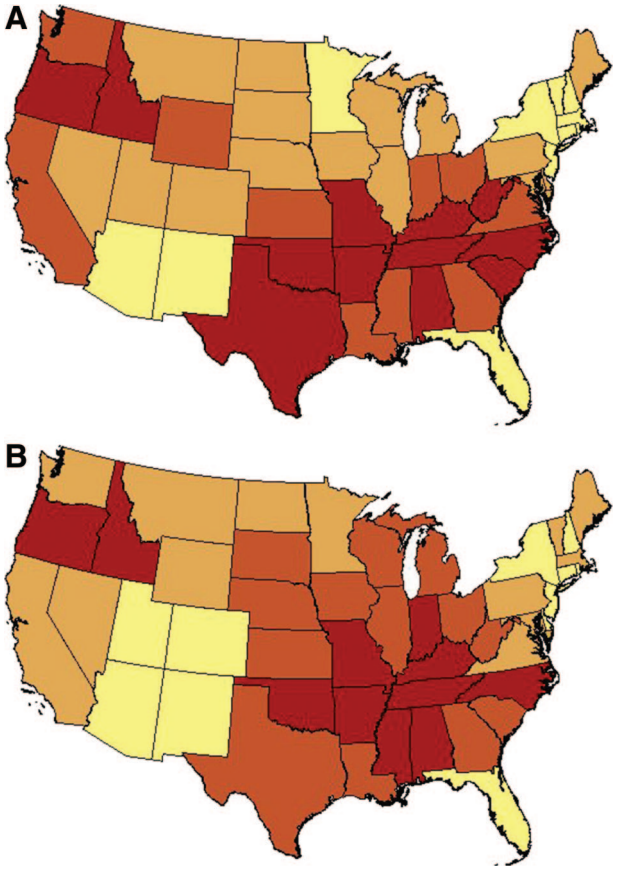

Figure. Age-adjusted rate of stroke death by state for European Americans aged ≥45 years: United States, 1999 to 2007. **A**, Women; (**B**) men. Yellow, first quartile; light orange, second quartile; medium orange, third quartile; dark orange, fourth quartile.

Idaho, a state with a small population, should be viewed with caution. Unlike previous studies, analyses were restricted to non-Hispanics. These data did not permit further analyses to explain observed geographic patterns.

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Table 1. States With the Highest Age-Adjusted Stroke Mortality Rate per 100 000 by Gender and Ethnicity in Non-Hispanics Aged ≥45 Years: United States, 2005–2007

Rank	AA Women	EA Women	AA Men	EA Men
1	Arkansas	Arkansas	Oregon	Oklahoma
2	Oklahoma	Oklahoma	Arkansas	Arkansas
3	Alabama	Tennessee	Alabama	Tennessee
4	Texas	Alabama	Tennessee	Alabama
5	Louisiana	Idaho	Kansas	North Carolina
6	Tennessee	West Virginia	Mississippi	Oregon
7	Oregon	North Carolina	South Carolina	Indiana
8	North Carolina	Kentucky	Nebraska	Kentucky
9	South Carolina	Oregon	North Carolina	Mississippi
10	California	Texas	Iowa	Alaska

AA indicates African American; EA, European American.

Table 2. Average Percent Change (APC) and Selected Age-Adjusted Rates of Stroke Mortality per 100 000 by Census Division, Gender, and Race in Non-Hispanics Aged ≥45 Years: United States, 1999–2007

Division	AAF	EAF	AAM	EAM
New England				
APC	−4.2	−5.0	−4.0	−5.3
1999	151	140	161	153
2007	112	99	109	102
Mid-Atlantic				
APC	−4.2	−4.3	−3.5	−4.7
1999	143	131	169	140
2007	110	95	137	99
East North Central				
APC	−3.9	−4.8	−3.7	−5.3
1999	203	173	249	184
2007	150	118	188	122
West North Central				
APC	−2.4	−4.6	−5.1	−4.9
1999	204	166	283	178
2007	168	115	202	120
South Atlantic				
APC	−5.1	−5.4	−5.0	−5.9
1999	236	163	287	166
2007	158	109	195	106
East South Central				
APC	−4.0	−4.6	−1.8	−5.2
1999	229	191	254	201
2007	171	137	242	133
West South Central				
APC	−3.1	−4.5	−3.3	−4.6
1999	236	187	260	184
2007	186	138	210	134
Mountain				
APC	−6.6	−5.6	−5.4	−6.6
1999	217	160	224	160
2007	132	106	141	94
Pacific				
APC	−4.9	−5.9	−5.2	−6.3
1999	256	186	279	188
2007	181	115	190	116

AA indicates African American; EA, European American; F, females; M, males.

Disclosures

None.

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Supplemental Material

Table S1. Classification rules used to assign counties to the six urbanization levels of the 2006 NCHS Urban-Rural Classification

Urban-rural category	Classification rules
Metropolitan	
Large central metro[1]	Counties in a metropolitan statistical area of 1 million or more population: 1) that contain the entire population of the largest principal city of the metropolitan statistical area, or 2) whose entire population resides in the largest principal city of the metropolitan statistical area, or 3) that contain at least 250,000 of the population of any principal city in the metropolitan statistical area
Large fringe metro	Counties in a metropolitan statistical area of 1 million or more population that do not qualify as large central
Medium metro	Counties in a metropolitan statistical area of 250,000 to 999,999 population
Small metro	Counties in a metropolitan statistical area of 50,000 to 249,999 population
Nonmetropolitan	
Micropolitan	Counties in a micropolitan statistical area
Noncore	Counties that are neither metropolitan nor micropolitan

[1]There must be at least one large central county in each large metro area.

Table S2. Age-adjusted stroke mortality rate per 100,000 by state and ethnicity in non-Hispanic women aged 45 years and over: United States, 2005-2007

Rank	Gender	Race	State	Deaths	Population	Crude Rate	Age Adjusted Rate
	Female	Black or African American	Rhode Island	13	22666	57 (Unreliable)	73 (Unreliable)
	Female	Black or African American	New Hampshire	2	3891	51 (Unreliable)	55 (Unreliable)
	Female	Black or African American	Maine	1	2678	37 (Unreliable)	49 (Unreliable)
	Female	Black or African American	Hawaii	3	7712	39 (Unreliable)	42 (Unreliable)
	Female	Black or African American	South Dakota	3	1340	224 (Unreliable)	334 (Unreliable)
	Female	Black or African American	Wyoming	3	1549	194 (Unreliable)	235 (Unreliable)
	Female	Black or African American	Utah	10	5886	170 (Unreliable)	223 (Unreliable)
	Female	Black or African American	Alaska	6	8516	70 (Unreliable)	120 (Unreliable)
1	Female	Black or African American	Arkansas	506	217842	232	231
2	Female	Black or African American	Oklahoma	227	128642	176	195
3	Female	Black or African American	Alabama	1248	659215	189	194
4	Female	Black or African American	Texas	2071	1280579	162	190
5	Female	Black or African American	Louisiana	1217	717485	170	188
6	Female	Black or African American	Tennessee	863	514556	168	186
7	Female	Black or African American	Oregon	43	27424	157	185
8	Female	Black or African American	North Carolina	1762	1036882	170	183
9	Female	Black or African American	South Carolina	1173	693218	169	183
10	Female	Black or African American	California	1940	1195941	162	181
11	Female	Black or African American	West Virginia	77	34868	221	181
12	Female	Black or African American	Florida	1973	1285334	154	180
13	Female	Black or African American	Missouri	558	345267	162	175
14	Female	Black or African American	Virginia	1266	806518	157	172
15	Female	Black or African American	Kentucky	263	161397	163	170
16	Female	Black or African American	Mississippi	847	533477	159	168
17	Female	Black or African American	Georgia	1783	1315911	135	165
18	Female	Black or African American	Pennsylvania	1156	700846	165	165
19	Female	Black or African American	Washington	108	86068	125	165
20	Female	Black or African American	Kansas	111	73707	151	164
21	Female	Black or African American	Indiana	402	272208	148	162
22	Female	Black or African American	Wisconsin	163	133061	123	162
23	Female	Black or African American	Iowa	37	25121	147	161
24	Female	Black or African American	Illinois	1411	1004844	140	158
25	Female	Black or African American	New Mexico	25	16981	147	155
26	Female	Black or African American	Ohio	1069	731625	146	154
27	Female	Black or African American	Michigan	1032	753227	137	152
28	Female	Black or African American	Delaware	106	88801	119	146
29	Female	Black or African American	Nebraska	42	30955	136	146
30	Female	Black or African American	Colorado	89	79022	113	145
31	Female	Black or African American	Nevada	99	86111	115	142
32	Female	Black or African American	New Jersey	776	629839	123	141
33	Female	Black or African American	Arizona	96	86046	112	138
34	Female	Black or African American	Maryland	943	893959	105	132
35	Female	Black or African American	Massachusetts	186	179871	103	126
36	Female	Black or African American	Minnesota	52	61258	85	123
37	Female	Black or African American	Connecticut	162	165706	98	119

38	Female	Black or African American	District of Columbia	294	228158	129	114
39	Female	Black or African American	New York	1300	1697270	77	83
Total	Female	Black or African American		27517	19038641	145	161
1	Female	White	Arkansas	2796	1483890	188	153
2	Female	White	Oklahoma	3414	1823708	187	153
3	Female	White	Tennessee	5399	3191371	169	151
4	Female	White	Alabama	3644	2196434	166	143
5	Female	White	Idaho	1182	759252	156	140
6	Female	White	West Virginia	1961	1202915	163	139
7	Female	White	North Carolina	6367	4121138	154	137
8	Female	White	Kentucky	3645	2417870	151	136
9	Female	White	Oregon	3380	2115810	160	136
10	Female	White	Texas	11898	7642402	156	135
11	Female	White	Missouri	5365	3220406	167	134
12	Female	White	South Carolina	2935	1964383	149	134
13	Female	White	Indiana	5335	3415300	156	131
14	Female	White	Georgia	4785	3522898	136	130
15	Female	White	Louisiana	2677	1806251	148	130
16	Female	White	Mississippi	1835	1178615	156	129
17	Female	White	Virginia	4896	3448480	142	129
18	Female	White	Kansas	2564	1495012	172	127
19	Female	White	Alaska	178	244745	73	125
20	Female	White	Ohio	9732	6407206	152	125
21	Female	White	Washington	4582	3271253	140	125
22	Female	White	California	18287	11435245	160	124
23	Female	White	Wyoming	381	291271	131	124
24	Female	White	Illinois	9074	5721794	159	121
25	Female	White	Michigan	7462	5230197	143	121
26	Female	White	Wisconsin	4898	3187731	154	121
27	Female	White	Iowa	3208	1836383	175	120
28	Female	White	Maine	1252	898024	139	118
29	Female	White	Montana	813	578921	140	118
30	Female	White	Nebraska	1632	990049	165	118
31	Female	White	Pennsylvania	12100	7427012	163	118
32	Female	White	Utah	1254	1023306	123	118
33	Female	White	South Dakota	777	458670	169	117
34	Female	White	Maryland	3150	2281610	138	116
35	Female	White	Nevada	1084	1001228	108	113
36	Female	White	Colorado	2457	2190964	112	112
37	Female	White	Delaware	563	423627	133	112
38	Female	White	North Dakota	644	382765	168	112
39	Female	White	New Mexico	841	654243	129	110
40	Female	White	Minnesota	3965	2882438	138	108
41	Female	White	Hawaii	221	208937	106	104
42	Female	White	Massachusetts	5088	3652154	139	103
43	Female	White	Vermont	473	409424	116	103
44	Female	White	Arizona	3402	2713742	125	101
45	Female	White	New Hampshire	916	810509	113	101

46	Female	White	New Jersey	5069	4002182	127	95
47	Female	White	Connecticut	2476	1921503	129	94
48	Female	White	Rhode Island	810	616044	131	92
49	Female	White	Florida	11792	8891581	133	91
50	Female	White	New York	9198	8444843	109	81
51	Female	White	District of Columbia	85	93528	91	76
Total	Female	White		201942	1.38E+08	147	118

Table S3. Age-adjusted stroke mortality rate per 100,000 by state and ethnicity in non-Hispanic men aged 45 years and over: United States, 2005-2007

Rank	Gender	Race	State	Deaths	Population	Crude Rate	Age Adjusted Rate
	Male	Black or African American	New Hampshire	2	5108	39 (Unreliable)	52 (Unreliable)
	Male	Black or African American	North Dakota	1	1343	74 (Unreliable)	306 (Unreliable)
	Male	Black or African American	Montana	2	1582	126 (Unreliable)	269 (Unreliable)
	Male	Black or African American	Idaho	3	2731	110 (Unreliable)	189 (Unreliable)
	Male	Black or African American	Wyoming	2	1865	107 (Unreliable)	188 (Unreliable)
	Male	Black or African American	Alaska	8	8883	90 (Unreliable)	180 (Unreliable)
	Male	Black or African American	New Mexico	19	18545	102 (Unreliable)	144 (Unreliable)
	Male	Black or African American	Hawaii	7	10065	70 (Unreliable)	135 (Unreliable)
	Male	Black or African American	Utah	3	7970	38 (Unreliable)	102 (Unreliable)
1	Male	Black or African American	Oregon	50	29316	171	270
2	Male	Black or African American	Arkansas	338	168669	200	259
3	Male	Black or African American	Alabama	972	488023	199	253
4	Male	Black or African American	Tennessee	681	387191	176	244
5	Male	Black or African American	Kansas	106	63203	168	235
6	Male	Black or African American	Mississippi	751	407247	184	235
7	Male	Black or African American	South Carolina	932	522494	178	232
8	Male	Black or African American	Nebraska	45	26460	170	227
9	Male	Black or African American	North Carolina	1285	785132	164	223
10	Male	Black or African American	Iowa	33	24318	136	220
11	Male	Black or African American	Oklahoma	171	106417	161	217
12	Male	Black or African American	Georgia	1436	988949	145	216
13	Male	Black or African American	Texas	1502	1022995	147	216
14	Male	Black or African American	Louisiana	911	548973	166	212
15	Male	Black or African American	Virginia	960	630635	152	212
16	Male	Black or African American	Wisconsin	151	105052	144	207
17	Male	Black or African American	Indiana	343	214663	160	203
18	Male	Black or African American	Florida	1455	1033298	141	193
19	Male	Black or African American	Missouri	382	256121	149	193
20	Male	Black or African American	Delaware	91	68691	132	192
21	Male	Black or African American	Ohio	840	560637	150	192
22	Male	Black or African American	Pennsylvania	790	518166	152	191
23	Male	Black or African American	Kentucky	185	128400	144	190
24	Male	Black or African American	California	1371	998947	137	188
25	Male	Black or African American	Illinois	1055	737595	143	185
26	Male	Black or African American	Michigan	803	577950	139	179
27	Male	Black or African American	Rhode Island	21	20080	105	179
28	Male	Black or African American	West Virginia	44	29709	148	178
29	Male	Black or African American	Nevada	103	79680	129	169
30	Male	Black or African American	New Jersey	557	469358	119	163
31	Male	Black or African American	Maryland	749	673400	111	162
32	Male	Black or African American	Washington	90	96325	93	156
33	Male	Black or African American	Colorado	76	79144	96	155
34	Male	Black or African American	Arizona	82	84946	97	145
35	Male	Black or African American	Connecticut	124	125189	99	137
36	Male	Black or African American	Massachusetts	120	146439	82	135

37	Male	Black or African American	District of Columbia	192	158651	121	131
38	Male	Black or African American	Minnesota	46	65434	70	124
39	Male	Black or African American	New York	941	1201337	78	102
Total	Male	Black or African American		20831	14695351	142	192
1	Male	White	Oklahoma	2107	1576670	134	151
2	Male	White	Arkansas	1760	1294855	136	150
3	Male	White	Tennessee	3224	2767758	116	148
4	Male	White	Alabama	2282	1898764	120	143
5	Male	White	North Carolina	3932	3554216	111	140
6	Male	White	Oregon	2275	1891301	120	139
7	Male	White	Indiana	3217	2976558	108	135
8	Male	White	Kentucky	2223	2088857	106	135
9	Male	White	Mississippi	1169	1016689	115	135
10	Male	White	Alaska	162	264603	61	134
11	Male	White	Idaho	789	707289	112	134
12	Male	White	Missouri	3186	2796587	114	134
13	Male	White	Georgia	2986	3101125	96	133
14	Male	White	West Virginia	1190	1052106	113	133
15	Male	White	Kansas	1535	1311554	117	132
16	Male	White	South Carolina	1861	1715241	108	132
17	Male	White	Texas	7176	6812998	105	130
18	Male	White	Iowa	1920	1607746	119	129
19	Male	White	South Dakota	514	416993	123	129
20	Male	White	Illinois	5355	4958232	108	128
21	Male	White	Nebraska	1000	870884	115	128
22	Male	White	Louisiana	1642	1586587	103	127
23	Male	White	Ohio	5812	5532875	105	127
24	Male	White	Michigan	4672	4670005	100	125
25	Male	White	Wisconsin	3021	2885096	105	125
26	Male	White	California	11492	10315475	111	124
27	Male	White	Virginia	2825	3037762	93	124
28	Male	White	North Dakota	417	347582	120	123
29	Male	White	Pennsylvania	7193	6342923	113	123
30	Male	White	Maryland	1923	2005599	96	120
31	Male	White	Washington	2819	2983014	95	119
32	Male	White	Montana	525	544514	96	115
33	Male	White	Maine	732	794675	92	114
34	Male	White	Vermont	304	368278	83	114
35	Male	White	Minnesota	2410	2603822	93	113
36	Male	White	Wyoming	237	280373	85	112
37	Male	White	Nevada	893	985752	91	110
38	Male	White	Massachusetts	2868	3081299	93	108
39	Male	White	Colorado	1493	2002709	75	107
40	Male	White	Hawaii	180	218763	82	104
41	Male	White	Connecticut	1503	1650580	91	103
42	Male	White	New Jersey	3169	3422370	93	103
43	Male	White	Rhode Island	489	513390	95	103

44	Male	White	Utah	778	942217	83	103
45	Male	White	Delaware	330	367809	90	101
46	Male	White	New Hampshire	512	736094	70	94
47	Male	White	New Mexico	505	579226	87	94
48	Male	White	Florida	8497	7816164	109	93
49	Male	White	Arizona	2139	2416584	89	87
50	Male	White	District of Columbia	62	92126	67	86
51	Male	White	New York	5613	7252630	77	84
	Male	White		124918	1.21E+08	103	119

Table S4 Average annual percent change in age-adjusted stroke death rate in African Americans (AA) in the West South Central States by urbanization: 1999-2007

	AA women	AA men
Large* central metro	-2.54	-2.24
Large fringe metro	-4.86	-3.30
Medium metro	-1.23	-3.22
Small metro	-4.84	-2.99
Micropolitan (non-metro)	-3.21	-3.09
Non-core (non-metro)	-3.56	-5.59

See Table S1 for definitions of urbanization levels