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Racial and Geographic Differences in Prevalence, Awareness, Treatment and Control of Dyslipidemia: The Reasons for Geographic and Racial Differences in Stroke (REGARDS) Study

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Key Words
Cholesterol · Risk factors · Risk factor management · Racial differences · Stroke prevention

Abstract
Background/Aims: There are racial and geographic disparities in stroke mortality, with higher rates among African Americans (AAs) and those living in the southeastern US ('stroke belt'). Racial and geographic differences in dyslipidemia prevalence, awareness, treatment and control may, in part, account for the observed disparities in stroke mortality. ***Methods:*** Reasons for Geographic and Racial Differences in Stroke (REGARDS) is a national observational study of community-dwelling black and white participants aged 45 and older, with oversampling from the stroke belt. As of January 15, 2007, 26,122 participants were enrolled and a fasting lipid panel was available of 21,068. Awareness, treatment and control of dyslipidemia were estimated overall and compared across race-sex-region strata. ***Results:*** There were 55% of the participants with dyslipidemia and no racial differences in prevalence. Adjusting for demographic and established stroke risk factors, AAs had a lower prevalence (OR 0.74; 95% CI: 0.66, 0.77) and were less likely to be aware (0.69; 0.61, 0.78), treated (0.77; 0.67, 0.89) and controlled (0.67; 0.58, 0.77) than whites. There was lower control outside of the stroke belt (0.87; 0.76, 0.99). ***Conclusion:*** Racial, but not geographic, differences in dyslipidemia management may play a role in the excess stroke burden in the Southeast.

Introduction

In the US, there are both racial and geographic disparities in stroke mortality, with African Americans (AAs) and those living in the Southeast (e.g., 'stroke belt') most susceptible [1, 2]. Although many potential contributors to these disparities have been proposed, the precise explanation(s) remain elusive [3]. While data from the Greater Cincinnati/Northern Kentucky Stroke Study (GCNKSS) suggest that the higher stroke mortality among AAs is attributable to a higher stroke incidence rate rather than a higher case fatality [4], data are much less clear to attribute the geographic disparities to a higher incidence versus a higher case fatality [3]. To the extent

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that there are regional and racial differences in incident stroke, it is reasonable to look for disparities in risk factors that could contribute to differences in incidence. Dyslipidemia has emerged as such a risk factor for ischemic stroke [5–8] and studies of statin agents in patients with coronary artery disease (CAD), hypertension, or diabetes have demonstrated a relative risk reduction in stroke incidence of approximately 15–30% [9–14]. Recently, the Stroke Prevention by Aggressive Reduction in Cholesterol Levels (SPARCL) study reported reductions in stroke and stroke or major coronary events in atorvastatin-treated patients with prior stroke or transient ischemic attack and no symptomatic CAD at baseline [15].

The role of dyslipidemia in explaining racial and geographic disparities in stroke has not been systematically studied. Differences in dyslipidemia prevalence and/or management may account for some of these disparities. As a step in addressing this possibility, we tested the hypothesis that racial (AA vs. white) and/or geographic (stroke belt vs. non-stroke belt) differences exist in dyslipidemia prevalence, awareness, treatment and/or control using a national population sample including a large AA population with oversampling from the stroke belt.

Subjects and Methods

Data from the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study were used to calculate the rates of prevalence, awareness treatment, and control of dyslipidemia in US AAs versus whites, and in participants living in the stroke belt versus non-stroke belt states. REGARDS is a national longitudinal observational study. Beginning February 2003 through October 2007, 30,228 individuals aged 45 and older were enrolled, with approximately equal representation of whites and AAs, men and women [16]. Twenty-one percent (goal was 20%) of the sample was selected from the 'buckle' of the stroke belt (coastal plain region of North Carolina, South Carolina, and Georgia, USA), 35% (goal was 30%) from the stroke belt states (remainder of North Carolina, South Carolina, and Georgia, plus Alabama, Mississippi, Tennessee, Arkansas, and Louisiana), and the remaining 45% (goal was 50%) from the other 40 contiguous states. Within each region, individuals were recruited using a combination of mail and telephone from commercially available lists of residents. Consent was obtained verbally and later in writing. For those agreeing to participate, self-reported demographic information and cardiovascular risk factors were obtained by computer-assisted telephone interview. Participants were asked 'have you ever been told by a doctor that you have high cholesterol or abnormal level of fats in your blood' and, if they responded yes, 'are you taking any medicine for it?' If the respondent was unsure, some of the common lipid medications were listed to probe. Physical measures were collected at an in-home examination including blood pressure, fasting blood (subsequently assayed for cardiovascular risk factors including a standard lipid panel) and urine samples, electrocardiogram record, and an inventory of current medications. The study methods were reviewed and approved by the Institutional Review Board at the participating centers. Additional methodological details are provided elsewhere [16]. This analysis is based on data through January 15, 2007, at which time 26,122 participants were enrolled and a fasting lipid panel was available of 21,068.

Cholesterol measurements were performed following an overnight fast (86% of participants). 'Dyslipidemia' was defined as being on lipid-modifying medication (i.e., treated) or, for those not on therapy, having a low-density-lipoprotein cholesterol (LDL-C), exceeding the clinical risk group-specific threshold in ATP III for consideration of drug therapy. A threshold of 100 mg/dl (2.6 mmol/l) was used for participants in the high- and moderately high-risk categories, 130 mg/dl (3.3 mmol/l) for those in the moderate-risk category and 160 mg/dl (4.1 mmol/l) for those in the low-risk category [17]. Participants were considered 'undiagnosed' if they were dyslipidemic but neither told by a medical doctor nor on lipid-modifying medication, 'aware' if they were told they were dyslipidemic by a medical doctor, 'treated' if they were aware and on lipid-modifying medication, and 'controlled' if they were on lipid-modifying medication and their LDL-C met the ATP III risk category goal. Use of a statin was recorded for those treated. 'Region' was dichotomized as residence in the stroke belt (including the buckle region) or the remaining 40 contiguous states.

Variables that could potentially confound the relationships between race or region with awareness, treatment and control of dyslipidemia were categorized into 3 broad classes. Demographic variables included age, sex, and current marital status (married or not married). Socioeconomic status variables were years of education (categorized as less than high school, high school graduate, some college, or college graduate), household income (USD <25,000, 25,000–50,000, and 50,000+), and whether the participant reported having health insurance (answering positively to 'Do you have any kind of healthcare coverage such as health insurance, a Health Maintenance Organization (HMO), or a government plan like Medicare or Medicaid?'). Risk factors considered were diabetes, hypertension, cigarette smoking (categorized as never, past, or current), current alcohol consumption (categorized as none, moderate, or heavy), body mass index (categorized as normal ≤24.9, overweight 25–29.9 or obese ≥30), and frequency of exercise (categorized by the question 'How many times per week do you engage in intense physical activity, enough to work up a sweat?' into never, <5 times per week, and ≥5 times per week). Diabetes was defined as a fasting glucose level greater than 126 ml/dl (7 mmol/l), nonfasting glucose greater than 200 ml/dl (11.1 mmol/l), or self-reported medication use for glucose control.

Statistical Analysis

The same analytic approach was taken to assess racial and regional differences in prevalence and for each of the 3 management outcomes (awareness, treatment, and control). First, univariate analysis was conducted to show the likelihood of having dyslipidemia or of being aware, treated, or controlled within strata defined by race, region, demographic factors, measures of socioeconomic status, and risk factors. Logistic regression analysis was then used to estimate the odds ratio (OR) for prevalence and each of the 3 outcomes in an incremental series of models that progressed from considering race and region to adding demographic

factors, then adding socioeconomic factors, and finally adding risk factors. Because of the sampling design of REGARDS, the regional differences are reported after adjustment for race, and the racial differences are reported after adjustment for region.

Results

Of the participants included in these analyses, 40% were AA, 60% were white and 55% lived in the stroke belt. The overall mean (SD) age was 65 (9.3) ranging from 45 to 94 years. The mean (SD) total and LDL-C were 192 (39) mg/dl [4.9 (1.0) mmol/l] and 115 (35) mg/dl [2.9 (0.9) mmol/l], respectively. Overall, 1,346 (6%) reported a stroke and 3,873 (18%) had heart disease.

Overall, 55% were dyslipidemic, and higher proportions of individuals with the following characteristics had dyslipidemia: male gender, older age, less education, lower income, less health insurance, diabetes, obesity, current or past smoking and abstinence from alcohol and exercise (table 1). Prior to adjustment, there was no statistically significant difference in prevalence of dyslipidemia by region or race. Using the 130 mg/dl (3.3 mmol/l) cutoff, dyslipidemia prevalence decreased to 47% overall with no racial differences (48% white and 47% black).

Prior to adjustment, there were no geographic differences in dyslipidemia awareness or treatment but control was modestly higher in the stroke belt (73 vs. 70%; $p = 0.02$). As regards racial differences, more whites were aware (81 vs. 75%; $p < 0.001$), treated (83 vs. 79%; $p < 0.001$) and controlled (77 vs. 63%; $p < 0.001$). Of the treated participants, 91% were taking a statin. Although fewer AAs were treated, slightly more of the treated AAs were taking a statin (94 vs. 90%; $p < 0.001$). Higher proportions of individuals with the following other characteristics were aware, treated and controlled: being married, higher income, health insurance, diabetes, hypertension, lower BMI and not currently smoking. More females were aware (82 vs. 75%; $p < 0.001$) but were equally treated and controlled compared with males. Higher proportions of individuals with more years of education were aware and controlled, but education was not associated with treatment. More individuals of advancing age were aware and treated but age was not associated with control.

Multivariate modeling indicated lower dyslipidemia prevalence in AAs (OR = 0.74; 95% CI: 0.66–0.77) and persistence of racial differences in awareness, treatment and control (table 2). AAs were significantly less likely to be aware (OR = 0.69; 95% CI: 0.61–0.78), treated (OR = 0.77; 95% CI: 0.67–0.89), or controlled (OR = 0.67; 95% CI: 0.58–0.77) after controlling for demographics, socioeconomic status, and stroke risk factors. The unadjusted and risk factor-adjusted mean LDL-C levels were higher in AAs versus whites [118.0 mg/dl (3.0 mmol/l) vs. 113 mg/dl (2.9 mmol/l), $p < 0.001$ and 114 mg/dl (2.9 mmol/l) vs. 108 mg/dl (2.8 mmol/l), $p < 0.001$, respectively]. Following adjustment, there were no differences in awareness or treatment by geography; control was lower outside of the stroke belt (OR = 0.87; 95% CI: 0.76–0.99).

Discussion

Using ATP III criteria, we found an overall dyslipidemia prevalence of 55% in a national, biracial, middle-aged to elderly cohort. Not unexpectedly, this exceeds the prevalence found in the Multi-Ethnic Study of Atherosclerosis (MESA) as that study enrolled subjects free of CAD [18] and the National Health and Nutrition Examination Survey (NHANES) 1999–2004, which reported a prevalence of 25%, as that study enrolled subjects as young as 20 years [19]. In addition, application of modified ATP III criteria using the more aggressive 100 mg/dl (2.6 mmol/l) cutoff explains some of the higher prevalence compared with older studies. In REGARDS, 79% of dyslipidemic patients were aware of their diagnosis and 82% were treated, 91% with a statin. Overall, 72% of the treated persons were controlled; this compares favorably with prior studies such as NHANES 1999–2004 which reported a 25% control rate in those with high cholesterol [19], the Lipid Treatment Assessment Project (L-TAP) which found only a 38% success rate in achieving NCEP (National Cholesterol Education Program) target LDL-C levels in community practice [20], and the MESA, which found a 41.7% control overall and a 75.2% control among treated persons [18].

We found no geographic differences in dyslipidemia awareness or treatment but did find a 13% lower control outside of the stroke belt. These results indicate that differences in dyslipidemia management do not account for the excess stroke burden seen in the Southeast.

REGARDS found no racial differences in the prevalence of dyslipidemia but AAs were less likely to be aware, treated or controlled than whites. Lower rates of awareness, treatment or control in AAs have been reported in previous studies [18, 20–22]. Unlike MESA [18, 23], racial differences in treatment and control were not significantly attenuated by adjustment for access and socioeconomic variables and risk factors. Furthermore, the OR for AA control is less than for treatment (0.65 vs. 0.80). Addi-

Table 1. Association of demographic, socioeconomic status and risk factors with dyslipidemia prevalence, awareness, treatment and control

	Prevalence of dyslipidemia n (%)	p value	Aware of dyslipidemia n (%)	p value	On medication n (%)	p value	Controlled lipids n (%)	p value
All	11,375 (55)		8,893 (79)		7,263 (82)		4,740 (72)	
Race								
White	6,689 (54)	0.0653	5,405 (81)	<0.0001	4,500 (83)	<0.0001	3,164 (77)	<0.0001
AA	4,686 (55)		3,488 (75)		2,763 (79)		1,576 (63)	
Region								
Other regions	5,159 (55)	0.5680	3,999 (78)	0.1137	3,255 (82)	0.5736	2,075 (70)	0.0207
Stroke belt	6,208 (54)		4,886 (79)		4,001 (82)		2,662 (73)	
Sex								
Female	5,705 (49)	<0.0001	4,647 (82)	<0.0001	3,771 (81)	0.2022	2,487 (73)	0.0948
Male	5,671 (61)		4,247 (75)		3,493 (82)		2,255 (71)	
Age group (years)								
45–54	797 (34)	<0.0001	596 (75)	<0.0001	463 (78)	0.0003	294 (71)	0.8656
55–64	4,172 (51)		3,303 (80)		2,654 (80)		1,753 (72)	
65–74	4,208 (62)		3,386 (81)		2,793 (83)		1,815 (72)	
75–84	1,963 (64)		1,453 (74)		1,230 (85)		795 (72)	
85+	234 (59)		154 (66)		122 (80)		82 (75)	
Currently married								
No	4,605 (54)	0.2810	3,555 (78)	0.0396	2,864 (81)	0.0316	1,753 (68)	<0.0001
Yes	6,766 (55)		5,335 (79)		4,398 (83)		2,986 (74)	
Urban/rural status								
Rural	2,118 (53)	0.2192	1,682 (80)	0.2357	1,404 (84)	0.0953	930 (73)	0.0514
Mixed	1,100 (54)		868 (79)		713 (82)		488 (75)	
Urban	8,161 (55)		6,346 (78)		5,149 (81)		3,325 (71)	
Years of education								
Not HS	1,670 (65)	<0.0001	1,214 (73)	<0.0001	988 (82)	0.4551	562 (64)	<0.0001
Graduate HS	3,121 (57)		2,457 (79)		1,982 (81)		1,272 (70)	
Some college	2,943 (53)		2,286 (78)		1,881 (82)		1,209 (70)	
Graduate college	3,635 (50)		2,935 (81)		2,411 (82)		1,698 (77)	
Income (USD)								
≤25,000	3,420 (60)	<0.0001	2,551 (75)	<0.0001	2,031 (80)	0.0017	1,181 (64)	<0.0001
25,000–50,000	3,583 (55)		2,804 (79)		2,294 (82)		1,521 (73)	
≥50,000	3,024 (49)		2,460 (82)		2,055 (84)		1,483 (79)	
Health insurance								
Yes	10,743 (55)	<0.0001	8,467 (79)	<0.0001	6,960 (82)	<0.0001	4,576 (72)	<0.0001
No	627 (47)		424 (68)		302 (71)		163 (59)	
Diabetes								
No	7,755 (48)	<0.0001	6,082 (79)	0.0140	4,881 (80)	0.0008	3,513 (76)	<0.0001
Yes	3,331 (78)		2,543 (77)		2,119 (83)		1,202 (61)	
Hypertension								
No	3,531 (41)	<0.0001	2,692 (77)	0.0005	2,096 (78)	<0.0001	1,504 (77)	<0.0001
Yes	7,756 (65)		6,134 (79)		5,109 (83)		3,207 (70)	
BMI category								
Underweight/normal	2,297 (44)	<0.0001	1,743 (76)	0.0126	1,384 (79)	0.0038	960 (76)	<0.0001
Overweight	4,301 (56)		3,404 (79)		2,772 (82)		1,862 (73)	
Obese	4,647 (60)		3,646 (79)		3,028 (83)		1,868 (69)	
Smoker								
Never	4,490 (48)	<0.0001	3,578 (80)	<0.0001	2,954 (83)	<0.0001	2,012 (74)	<0.0001
Past	5,040 (60)		4,023 (80)		3,348 (83)		2,172 (72)	
Current	1,817 (61)		1,270 (70)		943 (74)		547 (65)	
Alcohol consumption								
None	5,756 (58)	<0.0001	4,424 (77)	0.0012	3,621 (82)	0.3349	2,252 (68)	<0.0001
Moderate	4,637 (51)		3,707 (80)		3,009 (81)		2,069 (76)	
Heavy	756 (53)		589 (78)		492 (84)		339 (76)	
Exercise per week								
None	4,066 (58)	<0.0001	3,151 (78)	0.4101	2,594 (82)	0.1134	1,628 (69)	0.0010
<5	3,808 (53)		3,001 (79)		2,467 (82)		1,656 (74)	
≥5	2,417 (53)		1,883 (78)		1,512 (80)		1,026 (74)	

HS = High school.

Table 2. Multivariate model of racial and geographic differences in prevalence, awareness, treatment and control of dyslipidemia

			Unadjusted	Demographic + SES + risk factor adjusted
Prevalence	race	black vs. white	1.05 (1.00–1.11)	0.74 (0.66–0.77)
	region	other regions vs. stroke belt	1.02 (0.96–1.07)	1.01 (0.94–1.09)
Awareness	race	black vs. white	0.69 (0.63–0.75)	0.69 (0.61–0.78)
	region	other regions vs. stroke belt	0.93 (0.85–1.02)	0.92 (0.83–1.03)
Treatment	race	black vs. white	0.77 (0.69–0.86)	0.77 (0.67–0.89)
	region	other regions vs. stroke belt	0.97 (0.87–1.08)	0.95 (0.83–1.08)
Control	race	black vs. white	0.52 (0.47–0.58)	0.67 (0.58–0.77)
	region	other regions vs. stroke belt	0.88 (0.79–0.98)	0.87 (0.76–0.99)

Demographic = Control for age, sex, marital status, urban/rural; SES = socioeconomic status: further adjustment for income, education, insurance status; risk factor adjusted = further adjustment for diabetes, hypertension, smoking, alcohol use, physical activity level, and BMI.

tional studies are required to further investigate why treated AAs are less likely to achieve control. The REGARDS study supports the hypothesis that some of the excess stroke mortality in AAs may be related to differences in lipid control.

A recent meta-analysis of statin trials has indicated that each 39 mg/dl (1.0 mmol/l) reduction in LDL-C is estimated to reduce the risk of all strokes by 21.1% [23]. Therefore, the risk factor-adjusted difference in LDL-C of 6.2 mg/dl (0.16 mmol/l; 5.8%) in AAs versus whites translates into a predicted stroke excess of 3.4% in REGARDS AAs. The differences in cholesterol we observed would account for 2,720 additional strokes in US AAs annually (3.4% of an estimated 80,000 excess strokes in AAs) [4]. These strokes represent potentially avoidable events.

Although optimal stroke prevention strategies must focus on the total risk profile, understanding potential racial and/or geographic disparities in individual risk components is important. Significant improvements in the management of dyslipidemia are needed and should target populations such as AAs. Two national health objectives by 2010 were to reduce to 17% the prevalence of high blood cholesterol in US adults and to increase to 80% the proportion of adults who had their blood cholesterol checked during the preceding 5 years [24]. In order to achieve such goals, increased public and professional awareness of cholesterol and increased emphasis on treatment and control by public health agencies and their partners are imperative [25].

Our study is a large, comprehensive epidemiologic evaluation of racial and geographic differences in dyslipidemia but it does have some limitations. Abdominal aortic aneurysm is considered a CAD risk equivalent in ATP III and the REGARDS baseline questionnaire did not include these data. We estimate very few participants were miscategorized due to this limitation since studies indicate CAD and other risk factors leading to elevated Framingham Coronary Risk Score are associated with abdominal aortic aneurysm. We also had limited ability to uncover mechanisms leading to the observed differences, underscoring the need for additional study of why AAs are less likely to achieve control.

Conclusion

In the REGARDS study, AAs with dyslipidemia were less likely to be aware, treated or adequately controlled compared with whites. Inadequate treatment of dyslipidemia may explain some of the excess stroke burden in AAs. We found no evidence to support the contention that geographic differences in dyslipidemia management play a role in the excess stroke burden in the Southeast. Further research investigating the mechanisms for lower lipid control in AAs and targeted interventions to overcome those mechanisms are needed.

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Disclosure Statement

None.

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